NOTES AND CORRESPONDENCE

The Rarity of the 1 April 1946 Tsunami[1]

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ABSTRACT

Archaeological evidence now suggests that the 1946 tsunami may have been an event unique within the the last 2000 years. The earliest level of man's habitation on Nuku Hiva, the largest island in the Marquesas group, has been dated by C_{14} methods as 2080±120 years (1960 datum). A burial site in the valley of Ha'atuatua, on the northeast coast, is identified with this level: this burial site is located in sandhills instead of the usual lava blisters or tubes, and is, therefore, a very sensitive indicator of any disturbing event. The 1946 tsunami was the first event large enough to damage the burial site since its creation. Evidence exists for only a minor change in sea level during this period. Thus, the tsunami of 1 April 1946 should probably be considered to be at least a one-in-two-thousand years event.

1. Some archaeological evidence

The first settlement of man in the Marquesas Islands was probably made by Polynesians traveling, with the intent of exploration, from the western Polynesian Islands. The settlement date of the Marquesas Islands is estimated to be about 150 BC (Shapiro and Suggs, 1959).

Prior to the discovery of radiocarbon dating techniques, Linton (1925) published a monograph describing the sites associated with the pre-history of the Marquesas. As no excavation was conducted, artifact seriation [the archaeological equivalent of paleontology: see *Invitation to Archaeology* by James Deetz (1967), or Ford (1962)] could not be used.

Several expeditions to the Marquesas Islands sponsored by the American Museum of Natural History between 1956 and 1961 revealed considerable information on the pre-history. Based on radiocarbon dating and artifact seriation, the settlement period for the Marquesas is considered to be from 150 BC to 100 AD (Suggs, 1961).

Of interest to the tsunamist are observations recorded by the archaeologist working on Nuku Hiva, the largest island in the northwest group of the Marquesas Islands. In Fig. 1 are shown some of the sites that have been subjected to archaeological field mapping. The sites at which effects of the 1946 tsunami are notable are large dots. A site affected by the 1906 tsunami is indicated by a solid square. Only the oldest site will be discussed here; however, none of the other sites provided any data on tsunami effects which could lead to conflicting interpretations.

The valley of Ha'atuatua lies on the northeast coast of Nuku Hiva as shown in Fig. 1. The first settlers built a group of small houses directly on the sandy beach near the mouth of a stream. On the sand hills south of the houses they erected a small temple with an altar (an "ahu") forming the center of a burial ground.

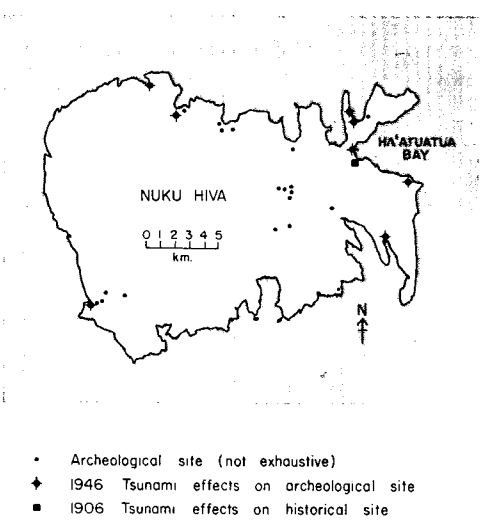

FIG. 1. Map of Nuku Hiva showing some archaeological sites and those sites notably affected by the 1 April 1946 Tsunami.

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These early burials appear to be definitely Polynesian; and because several artifacts found within the site are of materials not found anywhere in eastern Polynesia, this beach site is considered to have been founded by some members of the expedition that originally discovered the Marquesas Islands. Remains of animals brought by the settlers are in evidence, together with many tools. Small potsherds found at this site constitute the first pottery found in eastern Polynesia.

The burial site was undisturbed until the 1946 tsunami washed away a portion of the cover, exposing the bones. The natives referred to these as "pig bones" and mentioned them to an archaeologist who therefore visited the valley in 1956—to discover that they were actually human bones.

Radiocarbon dates show that the Ha'atuatua site was inhabited about 120 BC (2080±120 years before 1960).

2. Related evidence of rarity

Secular changes in the tectonic activity in the Aleutian arc have been considered by Grow and Atwater (1970) for longer time scales (millions of years). A secular change in seismicity appears to be required to understand the apparently large number of large-amplitude tsunamis in the Pacific Ocean in recent time, especially the 1946 tsunami. This is emphatically so as the archaeological data suggest that the 1946 tsunami was a maximum event over a duration *greater than* 2000 years. That the 1946 tsunami should have been the largest event in 2000 years at Ha'atuatua Valley on the Island of Nuku Hiva is quite surprising as this bay faces east, and the South American source area is known to have had repeated tectonic uplifts, presumably with attendant tsunamis. Furthermore, as shown in Fig. 2, there is an island called Ua Huka about 40 km east of Nuku Hiva which would probably amplify by focusing the tsunamis from South America. Indeed, the 1906 tsunami from South America wrecked a chapel at Ha'eta'a'o'o' on the south side of the beach at Ha'atuatua (see Fig. 1). No usable information is available for the bathymetry offshore of Nuku Hiva.

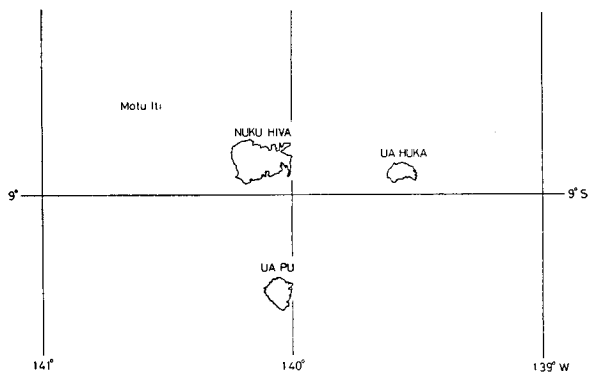

FIG. 2. Map of Nuku Hiva and Ua Huka.

The 1 April 1946 earthquake is *not* in Appendix XIV of Richter (1958), his list of great shallow earthquakes. Nor is this earthquake even listed in his Appendix XVI, the Chronological Bibliography. In a study of the space-time seismicity of the Aleutian arc (Figs. 3 and 4, Kelleher, 1970), a minimum magnitude of 7.7 is selected for study. Yet the 1 April 1946 earthquake, of magnitude 7.4, is invoked to explain a discontinuity in the projected spatial plot of epicenters and aftershock zones.

A mantle wave magnitude of 7.8 was obtained for the 1 April 1946 earthquake by Brune and Engen (1969).

Of great interest is the possibility that phenomena correlated with the occurrence of the 1 April 1946 tsunami may be equally rare. For example, the time rate of change of the squared Chandler amplitude has a peak near this time (Myerson, 1970).

Additional evidence of the rarity of the 1 April 1946 earthquake is provided by the vertical tectonic displacements prior to and during the 1964 earthquake (Plafker and Rubin, 1967). Prequake terraces on Middleton Island indicate, according to radiocarbon dating, five major uplift pulses, totalling 40 m, in the last 4470±250 years, with yet a sixth terrace being formed during the 1964 earthquake. Holocene tectonic emergence in the Gulf of Alaska has totaled up to 55 m in the past 7650 years with post-glacial submergence locally exceeding 90 m. In this coastal area, relative submergence has occurred during the past 930 years (possibly as great as 1360 years). Surely with all this discontinuous tectonic activity, an event with a magnitude greater than 7.4 and a vertical component greater than the 1 April 1946 earthquake would have happened—*if* the mechanism of the 1946 event were not very unique.

3. Conclusions

Archaeological evidence has been used to revise upward the lower bound for the rarity of the 1 April 1946 tsunami. The midden of a settlement in Ha'tuatua Bay on Nuku Hiva in the Marquesas Islands was most extensively intruded, for the first time since its emplacement, by the 1 April 1946 tsunami. Serendipitously, the intruded midden is, both by artifact seriation and radiocarbon dating, the earliest known settlement site of the Polynesians on this island. Other archaeological sites on the north and south coasts of Nuku Hiva were also intruded, but all are dated as later, so only confirming evidence is provided.

The lower bound for the frequency of occurrence of the 1 April 1946 tsunami may also be used to set an upper limit on the maximum energy of any meteorite that may have impacted in the deep Pacific Ocean during the past 2000 years, since such a meteorite would have generated a tsunami.

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