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RESEARCH LETTER

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Dating a Medieval Tsunami With Uranium-Series Techniques on Caribbean Corals

Key Points:

- Uranium-series analyses provide dates for 15 annually banded coral skeletons on the low Caribbean island of Anegada
- A subset of the corals was likely washed ashore in a Puerto Rico Trench tsunami that was previously dated to the 14th or 15th century CE
- U-series dates from a well-preserved coral with a life-like exterior date the tsunami to 1381–1391, probably during a summer or fall

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Supporting Information:

Supporting Information may be found in the online version of this article.

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Abstract Uranium-series dates from coral boulders constrain the timing of a medieval tsunami from the Puerto Rico Trench. Previously reported evidence for this tsunami includes hundreds of coral boulders that came to rest hundreds of meters inland on Anegada, British Virgin Islands. New U-series dates on these coral boulders provide limiting dates for the tsunami. The narrowest limits were by dating interior bands of a coral that retains the hemispherical form of a living coral colony, and which include adjustments for the number of annual density band couplets between the dated samples and the boulder exteriors. By those limits, the tsunami dates between 1381 and 1391 CE, and likely occurred during summer or fall. The tsunami is important as the only reported sign that the eastern Puerto Rico Trench has produced a great earthquake. The dating may aid in defining the earthquake source and in communicating tsunami hazards.

Plain Language Summary A tsunami flooded islands in the northern Lesser Antilles during the last centuries before Columbus. It is the only known example of a tsunami caused by faulting in the Puerto Rico Trench. The tsunami killed corals on the low-lying island of Anegada by stranding them hundreds of meters inland. Coral skeletons incorporate uranium from seawater, which decays to thorium. This radioactive decay enables dating of young coral skeletons to the nearest few years. Here we use this established dating method to bracket the time of the tsunami between the Common Era years 1381–1391. The dating may aid in searching for accounts of corresponding flooding in the British Isles, and it can be applied to communicating tsunami hazards in the Caribbean.

1. Introduction

Tropical reconstructions of past tsunamis and climates share a need for precise dates that uranium-series analysis of subfossil corals can provide. That shared need has produced two sets of U-series dates among 15 coral boulders and cobbles on Anegada, a low island in the northeastern Caribbean. This paper draws on both sets to narrow the time of a pre-Columbian tsunami from the nearby Puerto Rico Trench (Figure 1).

Uranium-series dating of coral skeletons uses seawater uranium that skeletal aragonite incorporates and thorium, a daughter isotope of uranium, that the skeleton retains (Barnes et al., 1956). Annual density band couplets in some corals provide sub-annual time resolution (Druffel, 1997; Hudson et al., 1976; Knutson et al., 1972). Modern U-series techniques allow individual couplets from recent centuries to be dated to the nearest few years (Edwards et al., 1988; C. C. Shen et al., 2008). Coral U-series analyses have yielded paleoceanographic timelines that are uncommonly precise (Hitt et al., 2022; Kilbourne et al., 2010; Xu et al., 2015). Tsunamis are among the events that have been precisely dated (Araoka et al., 2010; Meltzner et al., 2010; Mondal et al., 2018).

The tsunami precisely dated in this paper is the only one shown thus far to have been generated by faulting in the Puerto Rico Trench. The flooding stranded corals, limestone boulders, marine shells, and sand on Anegada (Atwater et al., 2017). It may also account for beds of sand or gravel that underlie salt ponds to the southwest on St. Thomas (Fuentes et al., 2017) and nearly 200 km to the east on Anguilla (Bigenet et al., 2021) and St. Martin

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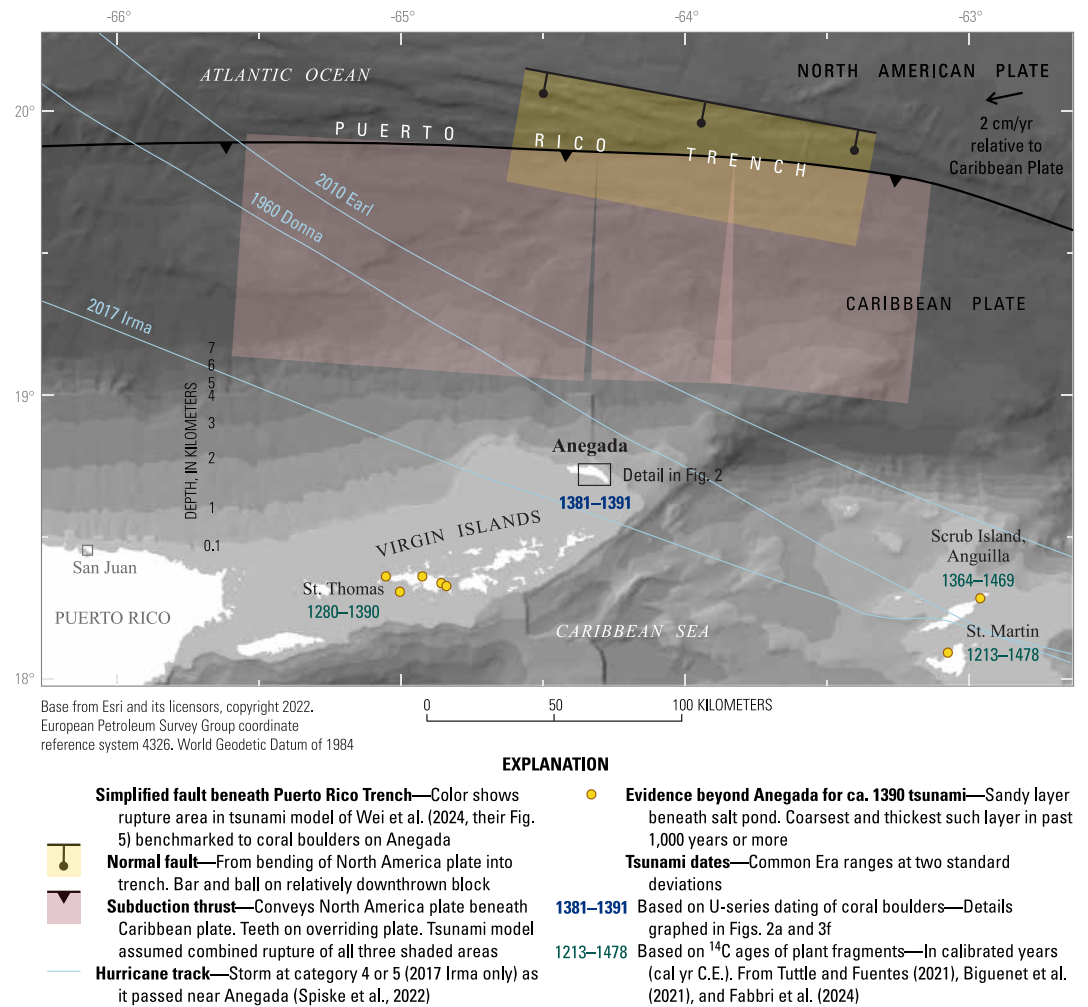


Figure 1. Regional index map. Diverse tsunami evidence on Aneгада (Atwater et al., 2017) has been linked to salt-pond deposits on St. Thomas (Fuentes et al., 2017; Tuttle & Fuentes, 2021), Anguilla (Biguenet et al., 2021), and St. Martin (Fabbri et al., 2024). The simplified normal fault plotted was used in recent tsunami simulations (Wei et al., 2024). Strong hurricanes passing by but having meager geologic effects on Aneгада include 1960 Donna, 2010 Earl, and 2017 Irma (Spiske et al., 2022).

(Fabbri et al., 2024). These various deposits have been dated by radiocarbon methods to broad time windows that overlap in the 14th century CE (Figure 1). Some of the deposits have served as ground truth for numerical tsunami simulations. These implicate either of two tsunami sources—extensional faulting in the descending North America Plate, or thrust rupture of its boundary with the Caribbean Plate—and they give parent earthquake magnitudes of 8.0 or more (Buckley et al., 2012; Cordrie et al., 2022; Wei et al., 2024). The average recurrence interval in either case probably spans thousands of years (ten Brink & Geist, 2025; Wei et al., 2024), and possibly more, as in the Lesser Antilles (Seibert et al., 2024). Neither source accounts for the deadly 1918 tsunami in western Puerto Rico, nor for any other tsunami in the five centuries of Caribbean written history (ten Brink et al., 2011; Thompson Jobe et al., 2024).

Refining the timing of the tsunami is important for defining and mitigating Caribbean earthquake and tsunami hazards. Eventual seismological applications may include distinguishing between a single long fault rupture and a geologically swift series of shorter ones. The fault rupture areas posited in Figure 1 (Wei et al., 2024), while centered on Aneгада, marginalize Anguilla and St. Martin. Do the medieval tsunami deposits on those eastern islands represent an additional rupture? U-series dating of tsunami-killed corals, if also achieved on Anguilla or St. Martin, might allow a separate, eastern rupture to be resolved. Further, the medieval tsunami on Aneгада

Table 1

Dates of U-Series Samples, Offsets From Nearest Part of Clast Exterior, and Corresponding Exterior Dates of Nine Inland Boulders on Anegada

Sample ID	Sample type	U-series date (yr CE, ± 2 s)	Offset from nearest exterior ($\pm \sim 2$ s)	Date of nearest exterior (yr CE, ± 2 s)	Comment
Hemispherical <i>Pseudodiploria strigosa</i> boulder south of Bones Bight (Figure 3, Figure S2 in Supporting Information S1)					
13AN5b	Core	1352.2 \pm 4.4	33 \pm 0	1385.2 \pm 4.4	Sample behind spalled face
13AN5a	Core	1354.7 \pm 2.5	34 \pm 0	1388.7 \pm 2.5	Sample behind spalled face
13AN6b	Core	1321.6 \pm 3.7	10 \pm 0	1331.6 \pm 3.7	Sample below spalled face
13AN6a	Core	1329.3 \pm 2.2	11 \pm 0	1340.3 \pm 2.2	Sample below spalled face
AN11	Hand	1278.6 \pm 4.5	20 \pm 5	1298.6 \pm 6.7	Outer part of spalled block
<i>Orbicella</i> boulder among old coral clasts near south shore west of Nutmeg Point (Figure S3 in Supporting Information S1)					
13AN8	Core	1043.8 \pm 3.0	20 \pm 10	1063.9 \pm 10.5	Exterior broken or eroded
<i>Orbicella</i> boulder south of Windlass Bight (Figure S4 in Supporting Information S1)					
13AN3	Core	1357.6 \pm 3.5	19 \pm 0	1376.6 \pm 3.5	Exterior broken or eroded
Overturned <i>Pseudodiploria strigosa</i> boulder south of Soldier Point (Figure S5B–S5D in Supporting Information S1)					
13AN10	Core	1335.9 \pm 2.3	36 \pm 0	1371.9 \pm 2.3	Exterior broken or eroded
AN16	Hand	1330.2 \pm 5.2	10 \pm 5	1340.2 \pm 7.2	~15 cm from core
Three additional coral boulders south of Soldier Point (Figure S5E–S5I in Supporting Information S1)					
13AN13	Core	1330.4 \pm 3.0	17 \pm 0	1347.4 \pm 3.0	Overturned. Exterior pitted
13AN4	Core	1041.1 \pm 3.9	9 \pm 2	1050.1 \pm 4.3	Bands indistinct
13AN16	Core	1282.4 \pm 2.7	15 \pm 0	1297.4 \pm 2.7	Deeply fractured
Large <i>Pseudodiploria strigosa</i> boulders with life-like form in Warner (Figure S6 in Supporting Information S1)					
AN30	Hand	1370.8 \pm 4.4	10 \pm 5	1380.8 \pm 6.6	Overturned but domal
AN28	Hand	1377.4 \pm 6.2	8 \pm 5	1385.4 \pm 8.0	Microatoll rim

Note. Offset gives count or estimate of annual density couplets. Error in exterior date combines the analytical dating error and the offset uncertainty in quadrature. Bold font identifies the two samples that most closely limit the tsunami date.

offers a kind of long-term tsunami warning that was tragically lacking for Indian Ocean shores in 2004. The more exact the Anegada tsunami date, the more compelling this Caribbean forewarning may become.

No less important, though beyond this paper's scope, is applying U-series dates from Anegada corals to comparing medieval climate with modern warming conditions. The skeletal aragonite of stony corals, modern and subfossil, can accurately record oceanographic conditions from the time they grew (Thompson, 2022). Caribbean examples include sub-annual proxy records of sea-surface temperature, not just in recent decades (Watanabe et al., 2002; Xu et al., 2015) but also in medieval time (Xu, 2014). One of the U-series dates reported here was used in a pilot study of medieval sea-surface temperatures at Anegada (Xu, 2014). Additional paleoceanographic samples account for the most exact of the tsunami dates derived below.

2. Materials and Methods

2.1. Coral Samples

This paper reports 20 U-series dates. Fourteen are from nine inland coral boulders thought to have been deposited by the medieval tsunami (Table 1). The other dates are from six clasts in modern storm rubble (Figures S5K–S5L in Supporting Information S1)—a berm-forming deposit that lines the shore at Soldier Point (Spiske, 2016; Spiske et al., 2022; Spiske & Halley, 2014). All 20 dates are graphed in Figure 2. In the supplement, Part 1 provides analytical details, Part 2 shows field context through maps and photographs, and Part 3 provides details about the radiocarbon reservoir ages used in Figure 2.

The inland boulder dating draws on two sample collections that differ in sampling method, material dated, and overall objective. Ten of dated boulder samples came from skeletal interiors that had been cored for geochemical analysis of medieval paleoceanographic variability. This effort prioritized large, long-lived coral boulders, whether or not they display the life-like form of a coral killed by the tsunami. In contrast, dating skeletal material

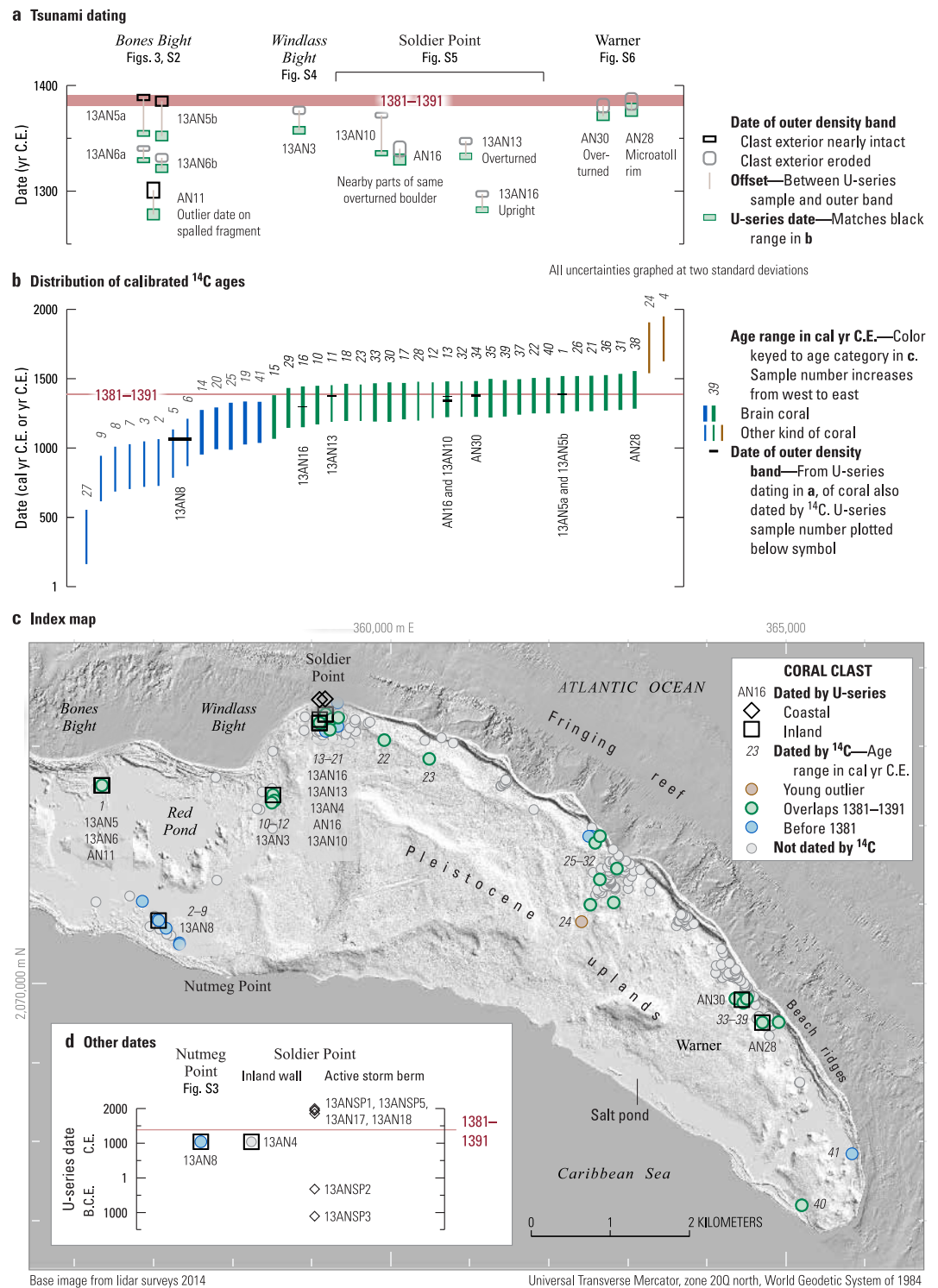


Figure 2. Summary of coral clast dating on Anegea by U-series methods and ¹⁴C analysis, (a) U-series dates and the coral-clast exterior dates derived from them (Table 1). The coral southeast of Bones Bight (Figure 3) dates the medieval tsunami to 1381–1391 CE (b) Age distribution of 41 calibrated radiocarbon ages among 39 clasts (Table S4 in Supporting Information S1) along with the U-series dates from seven of those clasts. (c) Index map to the dated samples. (d) U-series dates of corals that died centuries before or centuries after the medieval tsunami, most of them sampled from a modern storm berm.

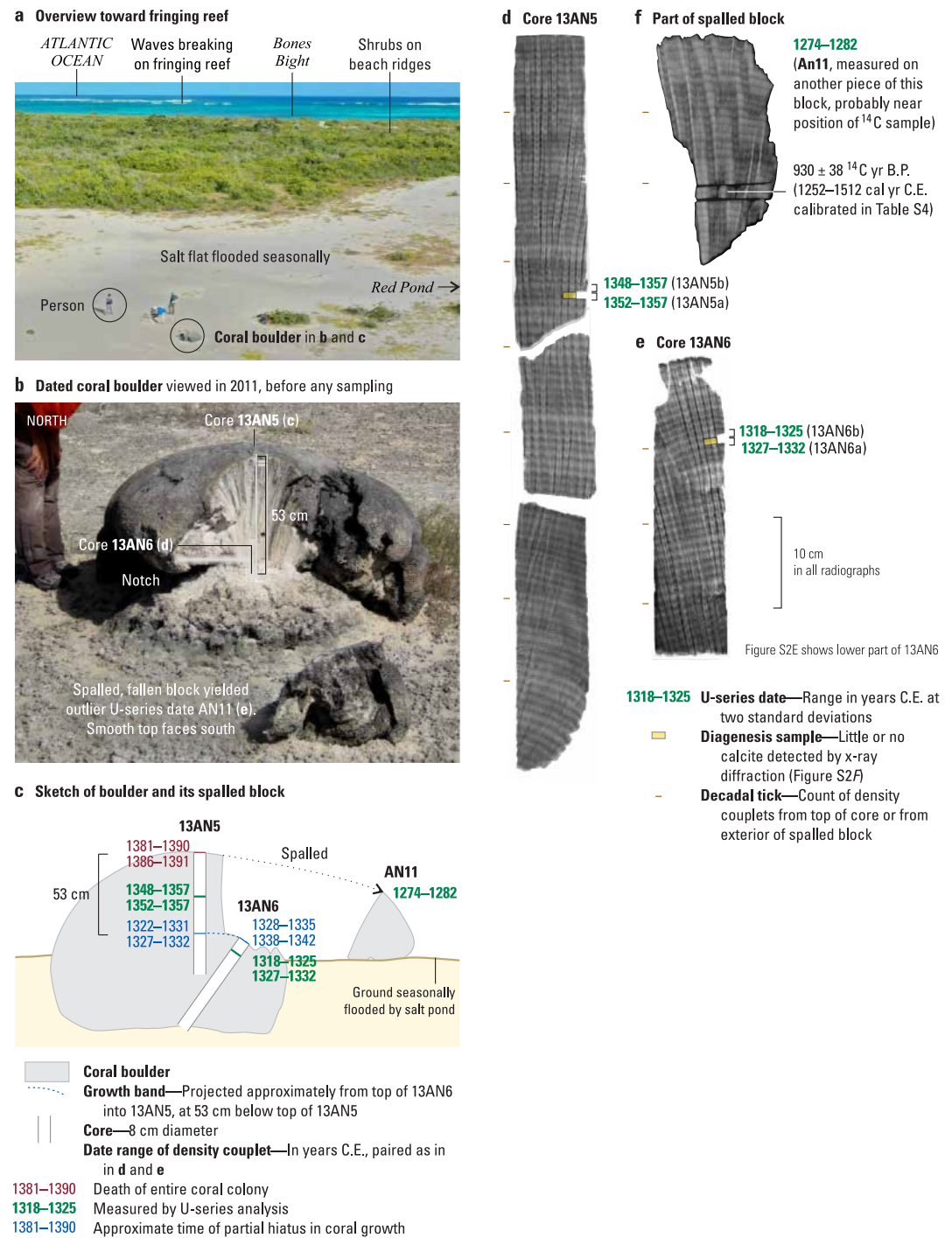


Figure 3. Multiply dated boulder of the brain coral *Pseudodiploria strigosa* southeast of Bones Bight. The figure illustrates congruent U-series dates from cores 13AN5 and 13AN6 with (a) providing an overview, (b) the dated coral, (c) sketch of the boulder, (d–f) x-radiographs of subsamples. The colony-death dates in (c) are derived by counting annual density bands between the U-series dates and the coral exterior in core 13AN5 (Table 1).

from the last years before the tsunami was the main goal for the other four inland samples. These samples were obtained from hand specimens that extended about 10 cm inward from weathered boulder exteriors.

These dual efforts overlap most usefully with five dates from a boulder of the brain coral *Pseudodiploria strigosa* southeast of Bones Bight (Figure 3). As shown previously (Atwater et al., 2017), that key boulder retains the

smoothly curved, dimpled exterior of a living coral colony. It came to rest upright, and spalling has exposed interior structure. Two of the dated samples were cut from adjoining density couplets in a core through the intact exterior behind the spalled face (13AN5a, 13AN5b). Another pair of couplets were dated from a core drilled below the spalled face (13AN6a, 13AN6b). In addition, a hand specimen was dated from the spalled fragment (AN11). The five dates are compared below, in Section 3.

2.2. U-Series Measurements and Calculations

The 16 U-series dates from the core samples were measured at the High-Precision Mass Spectrometry and Environment Change Laboratory (HISPEC), at National Taiwan University (NTU). In 2013, HISPEC began analysis with 400–980 mg subsamples. Each subsample was crushed into 0.3–2 mm³ pieces and physically cleaned with ultrasonic methods (Shen et al., 2008). A 100–200 mg aliquot was then taken for chemical analysis. Two additional samples analyzed in 2025 (13AN5b, 13AN6b) were similarly gently crushed before segments weighing 58 and 60 mg, respectively, were selected for chemical preparation and instrumental analysis. Isotopic compositions and concentrations were determined on a multi-collector inductively-coupled plasma mass spectrometer, Thermo Neptune, in the High-Precision Mass Spectrometry and Environment Change Laboratory (HISPEC), Department of Geosciences, NTU (Shen et al., 2012), which used million-year calcite standards in ²³⁸U-²³⁴U-²³⁰Th secular equilibrium (Cheng et al., 2013) and modern corals with known ages (Shen et al., 2012) to verify the methodology fidelity and accuracy. Procedural blanks, measured regularly, gave 6-month average values of 0.02 ± 0.01 pmol ²³⁸U, 0.002 ± 0.002 pmol ²³²Th, and 0.0003 ± 0.0003 fmol ²³⁰Th.

The four hand samples were measured at the Center de Recherche et d'Enseignement des Géosciences de l'Environnement (CEREGE), France. The dated subsample was taken from a piece approximately 2 cm³ that spans a few years of growth near the coral boulder exterior. About 2 g of coral samples were spiked with a mixed ²³³U-²³⁶U-²²⁹Th spike, before being totally dissolved in nitric acid for details on the preparation and calibration of the spike solution, see Deschamps et al., 2012). Chemical separation and further purification of U and Th fractions from the sample matrix followed the procedure described previously (Bard et al., 1996; Deschamps et al., 2004). U and Th fractions were coprecipitated with iron hydroxide by adding ammonium hydroxide, then separated on AG1-X8 anionic resin, and purified on UTEVA resin for U and on AG1-X8 resin for thorium. Long-term procedural blanks for total Th and U were below 40 pg for Th and 60 pg for U.

Isotopic compositions and concentrations were determined at CEREGE on a VG-Sector 54–30 thermal ionization mass spectrometer fitted with a 30 cm electrostatic analyzer and an ion counting Daly detector, following the procedure described in Deschamps et al. (2012). The internal errors on ²³⁰Th/²³⁸U and ²³⁴U/²³⁸U ratios are about 8‰ and 1‰ (2σ) respectively, resulting in age uncertainties of up to 6 years (on a sample dating to 1377 CE, see Table 1). The analytical reproducibility achieved in the course of this study on uranium measurement was assessed by replicate measurements of the NBS-960 standard, and yielded a mean value of ²³⁴U/²³⁸U = 0.9634 ± 0.0008 (2σ, n = 28), in excellent agreement with previous measurements at CEREGE (Bard et al., 1996; Delanghe et al., 2002), and with values reported in the literature (Andersen et al., 2004; Deschamps et al., 2003). Internal reproducibility on the coral matrix was also checked by replicate U-Th measurements of several samples from the IODP Tahiti expedition, and all showed good agreement within errors (Deschamps et al., 2012). External reproducibility on U-Th measurements was assessed through duplicate analyses of Tahiti coral samples conducted concurrently by the Oxford (see Thomas et al., 2009 for an overview of Oxford methods) and CEREGE labs, which again showed agreement within error (see Deschamps et al., 2012).

All ages reported use half-lives of nuclides reported in Cheng et al. (2013) and analytical errors in U-Th isotopic data are given as 2σ of the mean.

2.3. Assessing Diagenesis

Accurate U-series dating of a subfossil coral requires a closed system of uranium and thorium, without gain or loss from diagenesis. The subaerially exposed coral boulders in our study would be most susceptible to dissolution effects and secondary calcite precipitation. All but one (AN11) of our dates pass standard assessments for reliability as described by Obert et al. (2016). The corals have ²³⁸U concentrations typical of their taxa, seawater-like ²³⁴U/²³⁸U activity ratios and δ²³⁴U initial values, and low ²³²Th concentrations indicating that the fraction of non-radiogenic ²³⁰Th is almost negligible and therefore the correction on the age is on average 1 year and at most 5 years. We looked for traces of calcite in radiographs, under microscopes, and by X-ray diffraction (XRD).

All the paleoceanographic samples were examined in X-radiographs and under the microscope. We noticed no secondary cements or dissolution features in either—a protocol for identifying diagenesis as subtle as can be detected by XRD (Quinn & Taylor, 2006). Thin sections were examined in Maryland and crushed U-series samples were screened at HISPEC. XRD was applied to three of the cores and all four of the hand samples. Powdered subsamples of the cores were analyzed semi-quantitatively at the University of Maryland for relative comparisons of peak heights (Figure S2F in Supporting Information S1). XRD at CEREGE provided estimates of calcite contents of the hand samples, with uncertainty of $\pm 0.9\%$ (Text S1 in Supporting Information S1). These results are applied below, in Section 3.

2.4. Determining Ages of Boulder Exteriors Using U-Series Ages

We derived dates for the outermost part of the corals sampled by counting annual density band couplets outward from the U-series samples to boulder exteriors. Table 1 lists 14 such offsets between sample and exterior. The offsets are more exact where counted from radiographs than where estimated (± 5 yr) from sizes of hand specimens.

The coral boulders best suited for tsunami dating retain large, life-like skeletons that came to rest upright. The example we analyzed most thoroughly is the boulder southeast of Bones Bight (Figure 3). It retains the smooth hemispherical form of a colony that never crested above low tide. The radiograph of core 13AN5 provides exact offsets, of 34 and 33 density band couplets from two adjacent U-series samples to the hemisphere crest 28–29 cm above it (Figures 3c and 3d). The boulder broke above the level of an additional core 13AN6. Its outermost density couplet projects approximately to a depth of 53 cm below the top of 13AN5 (Figures 3b and 3c)—a projection used below in evaluating the U-series dates.

2.5. Calibration of ^{14}C Ages

We checked the U-series dates from the nine inland boulders for their consistency with 41 radiocarbon ages among 39 inland coral boulders and cobbles (Figure 2b). Doing so required converting the measured radiocarbon ages to Common Era time. We applied the calibration data Marine20 of Heaton et al. (2020) using CALIB version 8.2 (Stuiver & Reimer, 1993). We used a local medieval marine reservoir adjustment, ΔR , of -216 ± 44 ^{14}C years, from pairing the new U-series dates with ^{14}C ages in the eight inland boulders from which ^{14}C ages are available (Part 3 in Supporting Information S1).

3. Comparisons Among U-Series Results

The 20 U-series dates range across the past three millennia. Most of that range comes from the cobbles of the modern storm berm at Soldier Point (Figure 2d). Among the nine inland boulders, the oldest dates are in the 11th century CE—one each from south of Soldier Point and close to the island's south shore near Nutmeg Point. The other seven inland boulders gave U-series dates in the 13th and 14th centuries CE (Figure 2a). These boulders, which we apply to tsunami dating, flank the island's north shore, which is fringed by a coral reef and which faces the Puerto Rico Trench. They span a shore-parallel distance of nearly 10 km from Bones Bight and Windlass Bight in the west, through an area south of Soldier Point, to Warner.

U-series dates on corals can be evaluated by comparing multiple dates on the same coral skeleton (Obert et al., 2016; Scholz & Mangini, 2007). In our most direct comparison, cores of the brain-coral boulder southeast of Bones Bight yielded four dates that are mostly or entirely congruent (Figures 3c–3e). In the core drilled from the boulder's smooth crest, the dates from adjacent annual couplets are indistinguishable at 1352.2 ± 4.4 (13AN5b) and 1354.7 ± 2.5 (13AN5a). In the other core (13AN6), spudded from a level 53 cm below the colony top, the similarly paired dates are 1321.6 ± 3.7 (13AN6b) and, one density couplet earlier, 1329.3 ± 2.2 (13AN6a). The 13AN6 pair are statistically indistinguishable by a Welch's *t*-test ($p = 0.094$, 1 degree of freedom), and their confidence intervals overlap at 90% though not at 95%. The Bones Bight boulder provides a further test for congruence among the four dates. The height of the spalled face allows the outermost density couplet in core 13AN6 to be projected approximately into core 13AN5 at a depth of 53 cm below the smooth crest. By that projection, dates of 1328–1342 in 13AN6 overlap with dates of 1322–1332 in 13AN5 (Figure 3c).

Two inland boulders show distinct differences between the date on a hand specimen with the date or dates on core samples. In the Bones Bight boulder, a hand specimen from near the top of the colony gave a date of 1278.6 ± 4.5

(AN11). By contrast, this date is near the bottom of the colony as judged from the replicated dating of core 13AN6 (Figure S2E in Supporting Information S1). Evidence for an open system in AN11 includes a ^{238}U content that is outside the accepted range for pristine corals (Edwards et al., 2003; C. C. Shen et al., 2008; G. T. Shen & Dunbar, 1995). In addition, AN11 contained detectable calcite ($1.5\% \pm 0.9\%$) whereas the skeletal material adjacent to the samples from 13AN5 to 13AN6 did not (Figure S2F in Supporting Information S1). A smaller discordance is shown by pairing of dates on a core (13AN10) and a hand sample (AN16) from an overturned coral south of Soldier Point (Figure S5G–S5I in Supporting Information S1). After offsets, that boulder's exterior is 1371.9 ± 2.3 CE in the core and 1340.2 ± 7.2 CE in the hand sample (Table 1). Both 13AN10 (Figure S2F in Supporting Information S1) and AN16 (Text S1 in Supporting Information S1) showed detectable calcite by XRD.

4. Tsunami Dating

In view of these comparisons, the tsunami is dated most reliably by the paired U-series dates from core 13AN5 of the Bones Bight boulder. These dates imply coral death in 1381–1390 or 1386–1391 CE—ranges we combine broadly as 1381–1391 CE. That decade overlaps with two-thirds of ^{14}C ages on the island's inland coral boulders (Figure 2b), and it is also consistent with exterior dates of the rest of the nine boulders for which U-series dates are available, because each of these dates either overlaps with or precedes 1381–1391 (Figure 2a).

For coral colonies that the tsunami brought ashore, boulder exteriors older than 1381–1391 can be expected of skeletons that have been eroded, broken, and (or) overturned. Two of the inland boulders cored for paleo-oceanographic work came to rest upside down; the cores drilled through them do not necessarily intersect the youngest part of the coral skeleton (13AN13, 13AN10; Figures S5D, S5G in Supporting Information S1). Other U-series-dated corals died long before the tsunami entrained them—from the fringing reef, from an ancestral Soldier Point storm berm, or from an unidentified source for a group of old boulders near Nutmeg Point (^{14}C ages 2–9 in Figure 2b). Like the boulders of Pleistocene limestone washed inland by the tsunami (Figure S4 in Supporting Information S1), the two 11th-century corals (13AN4, 13AN8) were probably preexisting objects in the 14th-century tsunami's path. A coral transported by the tsunami necessarily predates the tsunami itself.

Density banding may give the tsunami season. The boulder coral *Orbicella faveolata* in nearby Puerto Rico forms dense bands in the early boreal summer (Watanabe et al., 2002). We speculate that the brain coral *Pseudodiploria strigosa* has similarly timed density banding in the climatically and oceanographically similar Virgin Islands. In the outermost density band couplet in core 13AN5, a complete low-density band is capped by a nearly fully formed high-density band (Figure 3d). By the *Orbicella* analogy, that couplet indicates death during or soon after early summer. If four centuries of weathering removed the outermost few millimeters of the hemisphere, the tsunami occurred between the middle of summer and early fall.

No evident tsunami is dated by the 11th-century corals 13AN4 and 13AN8. Those clasts, like boulders of Pleistocene limestone (Figure S4 in Supporting Information S1), can be interpreted simply as relicts in the tsunami's path. The 14th-century tsunami may have entrained 13AN4 from an ancestral storm berm at Soldier Point, where the modern deposits include corals thousands of years old (Figure 2c). As for 13AN8 and its old neighbors in the south, these clasts lack a visible source, but the 14th-century tsunami ran among them as judged from radiocarbon ages of nearby marine mollusks (Figure S3C in Supporting Information S1).

5. Hazard Implications

This improved tsunami dating opens up the possibility of identifying written records of flooding and damage that it may have caused. Written records of far-field waves could be sought in the British Isles, toward which minor rays of a Puerto Rico Trench tsunami may be directed (Cordrie et al., 2022). Such a transoceanic strategy, using written records in Japan, yielded estimates of 18th-century earthquake parameters in Cascadia (Satake et al., 2003) and Chile (Carvajal et al., 2017).

The dating may also aid in communicating tsunami hazards during preparedness exercises such as Caribe Wave. In 2024 that regional exercise, with nearly a half million registrants, tested emergency response to two hypothetical tsunamis, one of them generated along the Puerto Rico Trench (Maisonet Gonzalez & von Hillebrandt-Andrade, 2024). Future scenarios can be grounded in a visibly evidenced tsunami that has been confidently dated to almost exactly one century before Columbus.

Conflict of Interest

The authors declare no conflicts of interest relevant to this study.

Data Availability Statement

The analytical data for this project are archived at EarthChem.org. They can be cited as Kilbourne et al. (2025) and may be found at <https://doi.org/10.60520/IEDA/113605>.

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Erratum

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