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The Pacific Archaeology Radiocarbon Database

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ABSTRACT

This paper describes the Pacific Archaeology Radiocarbon Database (PARD), which includes radiocarbon data from archaeological sites excavated in an area commonly described as Near and Remote Oceania. The collated ^{14}C database is available using ArcGIS Online, an online geospatial system with searchable fields and locational navigation. The online PARD currently has over 17,000 radiocarbon measurements from archaeological sites from over 300 islands in the Pacific. The database contains many inconsistencies reflecting the long history of radiocarbon dating in the Pacific and issues relating to date calculation, precision, contamination removal, in-built age, and contextual uncertainty. While 'chronometric hygiene' protocols have demonstrated the reasons for treating such radiocarbon ages with caution, the presence of these data can still provide important information. The location of early excavations, distribution of site types at certain broad time periods, and other such information are useful in providing frameworks for future research. The PARD is a valuable starting point for researchers and communities in the Pacific. It has the potential to assist researchers in coordinating site location data for excavations and promises to aid a more extensive investigation of key research themes. The accessibility of the data online allows stakeholders, particularly indigenous groups across the Pacific, to improve their access to and understanding of the value of archaeological research.

Cet article décrit la base de données radiocarbone archéologique du Pacifique (PARD), qui comprend des données radiocarbone provenant de sites archéologiques fouillés en Océanie proche et lointaine. La base de données ^{14}C compilée est accessible via ArcGIS Online. La PARD en ligne contient actuellement plus de 17,000 mesures radiocarbone provenant de sites archéologiques de centaines d'îles du Pacifique La localisation de fouilles la répartition par types de site, grande période et autres fournissent un cadre utile pour de futures recherches. Les données de localisation de sites clés pourraient permettre de réalisation d'études plus approfondies.

1 | Introduction

Regional radiocarbon (^{14}C) databases have been developed, primarily to support archaeological and environmental research as well as community heritage management. As the quantity of data available for archaeologists has increased dramatically and continued to grow in recent years, numerous initiatives have endeavoured to amass large amounts of radiocarbon data in online, crowd-sourced databases. The Canadian Archaeological Radiocarbon Database (CARD, Martindale et al. 2016) has attempted to achieve global coverage, but it lacks dates from the Pacific region, except for some around Alaska and Australia. Australia has also been the focus of data collection with the creation of the SahulArch data within the OCTOPUS database

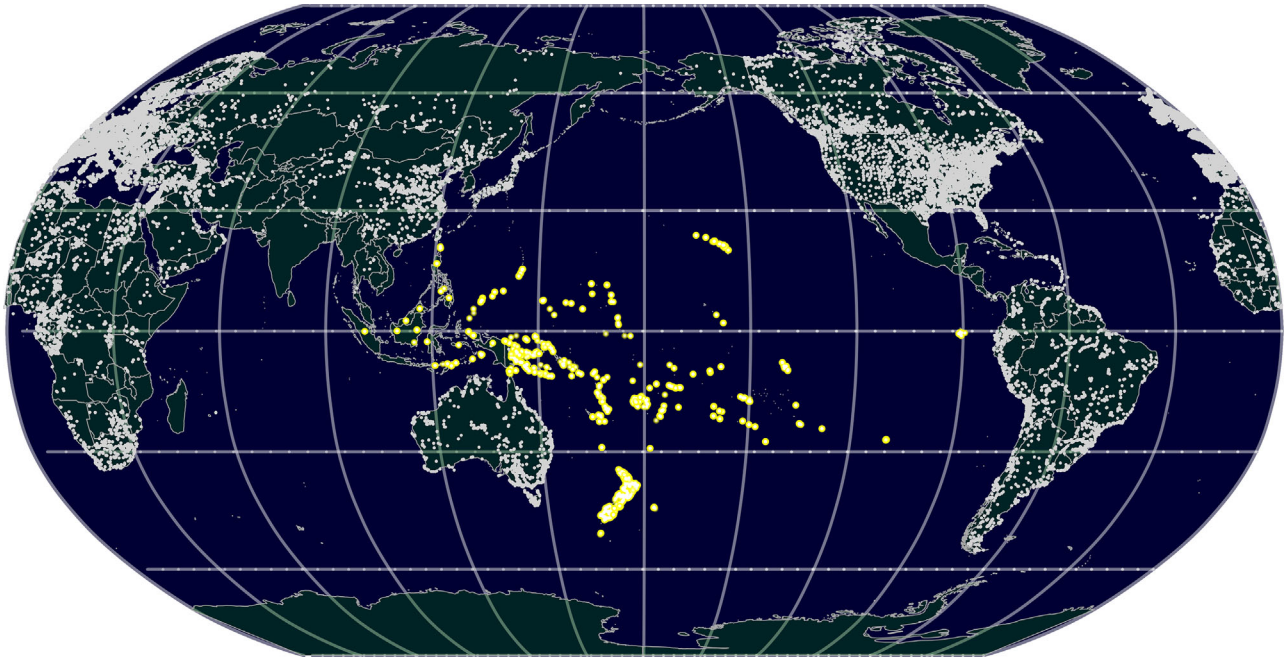

FIGURE 1 | Map showing the distribution of radiocarbon data as stored in the PARD (yellow dots) and those recorded in other databases (grey dots), including XRONOS.CH, p3k14c (Bird et al. 2022), SahulArch (Saktura et al. 2022), Japanese data (Kudo et al. 2023) and Canadian data from CARD (Martindale et al. 2016).

(Codilean et al. 2022; Saktura et al. 2021) that collates a range of radionuclide, luminescence, and radiocarbon ages associated with Pleistocene settlement there. An extensive, curated collection of ^{14}C data from Japan has been published recently (Kudo et al. 2018, 2023) and has radically improved the situation for Japan, with almost 40,000 measurements now available. The most ambitious coverage of the globe includes projects like XRONOS (xronos.ch[1]), which incorporates multiple datasets, including the *p3k14c* (Bird et al. 2022) with over 350,000 dates (as of January 2025), pulling together data from a range of collections. Notably, however, XRONOS contains only sparse coverage of the Pacific, with 125 ^{14}C measurements for Rapa Nui but little to no representation of most other Oceanic islands.

Within the Pacific, there have been several geographically limited attempts to collate datasets of radiocarbon data. These syntheses, mostly published in research articles, theses, and books, have focused on individual islands or archipelagos or address specific research questions (e.g., Athens et al. 2014; Carson 2005; Duarte 2012; Kirch and McCoy 2007; McCoy 2007; Mulrooney 2013; Rieth et al. 2011; Wilmshurst et al. 2011). A notable exception is the online Aotearoa New Zealand Radiocarbon Database (ANZRD; Bickler and Petchey 2024; Petchey et al. 2022), which replaces an earlier collection of data in the NZ Radiocarbon Database (McFadgen et al. 2000), and brings together over 4600 ages from more than 1800 sites. However, there has been no centralised management of archaeological ^{14}C data across the Pacific Islands (Figure 1[2]) despite its importance to the story of human migration across the globe (e.g., Bellwood et al. 2006, Gamble 1993; Irwin 1992; Kirch 2017; McNiven et al. 2011; Walter et al. 2017) and evidence of increasing genetic complexity and linkages to environmental drivers (e.g., Eisenhofer et al. 2017; Nägele et al. 2025; Oliveira et al. 2022).

This paper describes the Pacific Archaeology Radiocarbon Database (PARD), which comprises radiocarbon data from archaeological sites excavated in the area commonly described as Near and Remote Oceania (Figure 2). It is an expansion of the Aotearoa New Zealand Radiocarbon Database described in Bickler and Petchey (2024 and Petchey et al. (2022). The collated ^{14}C database is available using ArcGIS Online, an online geospatial system with searchable fields and locational navigation. Public access to the online viewer is via the Waikato Radiocarbon Laboratory webpage.[3]

2 | The Data

The minimum information required for each ^{14}C measurement included in the PARD is as follows:

- Measuring laboratory prefix and unique identification number.
- Result (Conventional Radiocarbon Age [CRA] and error).
- Material dated (taxa if known).
- Location by island, island group/region.
- Reference(s) with relevant links where available.

We have obtained this information from published academic papers and archaeological reports, many of which are from the cultural resource management (CRM) sector in Aotearoa/New Zealand, Hawai'i, and the Mariana Islands. Research undertaken in island groups such as Palau (e.g., Liston 2005), Rapa Nui (e.g., DiNapoli et al. 2021; Lipo n.d.[4]; Martinsson-Wallin and Crockford 2002; Mulrooney 2013), Sāmoa (Addison and Asaua 2006;

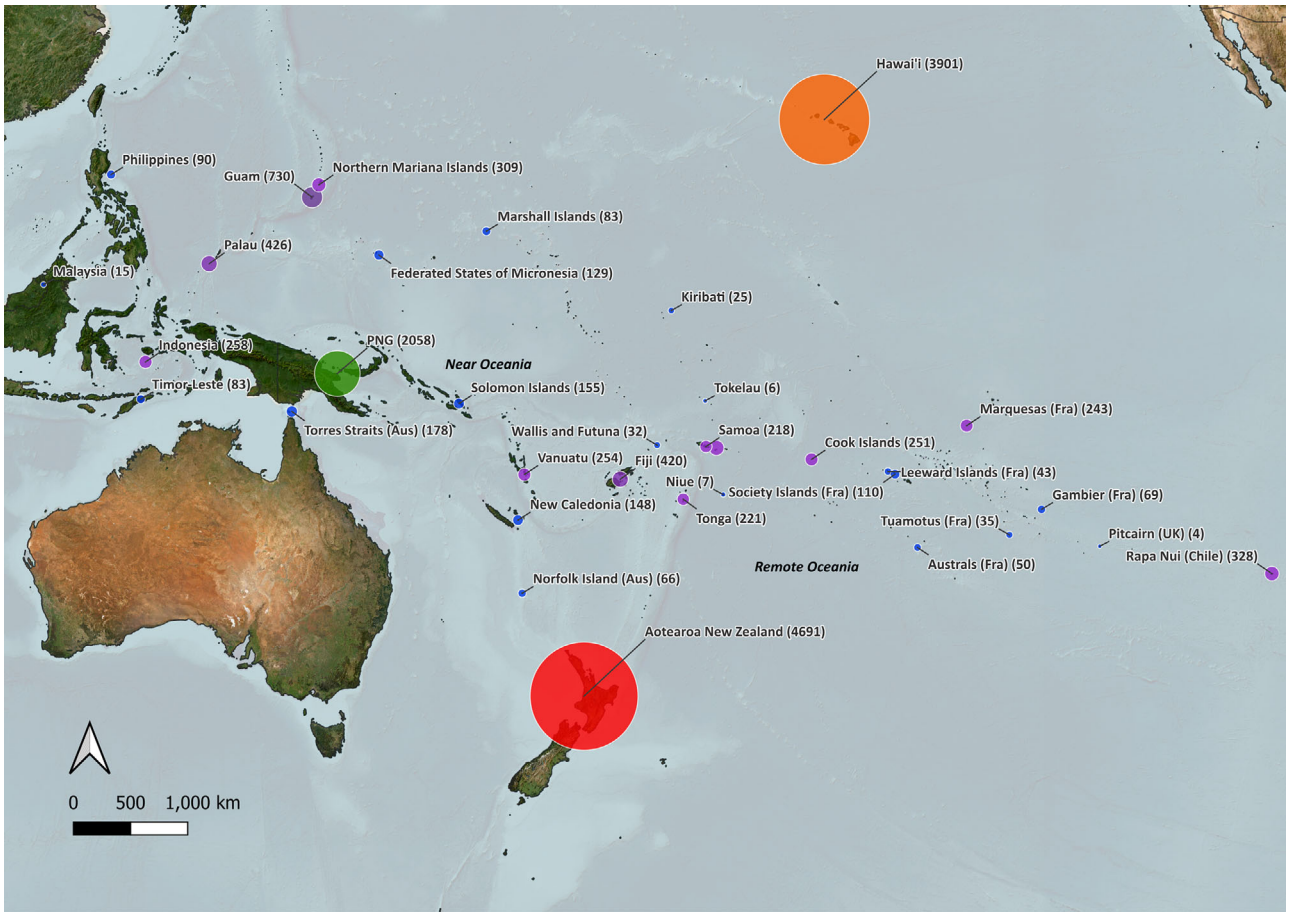

FIGURE 2 | Distribution of dated archaeological samples by island group (colours and size of circles relative to indicated count) from the PARD. Environmental samples and dates from human bone are not included (French Polynesian island groups indicated by "Fra", with Leeward Islands referring to the Leeward Society Islands).

Rieth and Hunt 2008), Fiji (Clark and Anderson 2009), Hawai'i (e.g., Athens et al. 2014; Carson 2005; Duarte 2012; McCoy 2007; Rieth et al. 2011), Vanuatu (Henderson et al. 2025) and East Polynesia more broadly (e.g., Anderson et al. 2019; Spriggs and Anderson 1993; Wilmshurst et al. 2011) enabled radiocarbon data from some islands and island groups to be rapidly uploaded. However, in most instances, the data collection process was largely manual, whereby individual reports and publications were combed for relevant data, which was then standardised for entry into the PARD. Minor errors or anomalies with the data were typically identified with older reports, most notably in the recording of location (see Section 3 below) and the categorisation of dated materials.

As is typical across the Pacific, peer-reviewed and other academic research publications describing archaeological studies in Hawai'i do not capture all radiocarbon measurements from archaeological contexts, as the CRM sector completes most investigations. The State of Hawai'i's Department of Land and Natural Resources (DLNR) State Historic Preservation Division (SHPD) Library is available online via the Hawai'i Cultural Resource Information System (HICRIS[5]), but the database is not easily searchable. Pacific Legacy Inc. therefore provided access to its library of scanned reports and publications to improve the coverage of the dataset for Hawai'i (over 12,000 files), and the International Archaeological Research Institute, Inc. (IARII) provided access to its unpublished ^{14}C dataset for the archipelago. We programmatically searched the Pacific Legacy library files to identify those most likely to include radiocarbon ages, then manually verified the results. Likewise, CRM reports contain most of the dates from the Mariana Islands; IARII provided access to their unpublished ^{14}C database for that region. IARII also provided access to their ^{14}C database for Sāmoa (also see Morrison et al. 2018). We note that IARII's Hawai'i, Sāmoa, and Guam datasets have not been systematically updated for several years, and reviews of CRM reports and other publications will add additional radiocarbon data. Radiocarbon measurements from French Polynesia are coded in the PARD by archipelago rather than their official national identity. This classification reflects archaeological research interests; however, the geographic nature of the data allows for the re-coding of the data to reflect other political, social, or environmental systems.

We have included data from Southeast Asia and geographically distinct areas of Australia (e.g., Norfolk Island and the Torres Strait Islands) in the PARD because of the overlap between research on the origins of migrations from Southeast Asia and subsequent human expansion into Oceania. However, the collection of these records is in its early stages and largely overlaps with the SahulArch project (Saktura et al. 2021). Differences in the reporting methodologies of the PARD and SahulArch meant that the source material had to be acquired and cross-checked

to ensure consistency with the other island datasets in the PARD. Currently, larger Pacific Island nations such as Japan, the Philippines, most of Southeast Asia and the Pacific coast of the Americas are not included in the PARD. However, as noted, Kudo et al. (2018, 2023) have provided comprehensive data for Japan.

2.1 | Laboratory Number

The ^{14}C laboratory number is a unique identifier, where the prefix indicates the measuring lab (i.e., the Waikato University Radiocarbon Dating Laboratory, denoted as Wk- or WkA-). This number is assigned by the measuring lab for each sample. A list of global ^{14}C laboratory prefixes is available from the University of Arizona Radiocarbon Laboratory.[6] This list contains over 300 laboratories, with over 60 represented in the PARD. Some are no longer operational, while others have undergone changes over the years, resulting in different prefixes being used. Reporting of these code prefixes is not always consistent in the literature, and in rare situations, the publication source does not report this number. Although the measuring laboratory prefix and unique identification number are given as prerequisites for inclusion in the PARD, we have included these 'unreferenced' measurements in case of future validation. Occasionally, as part of quality-control testing or intra-laboratory verification, the same laboratory number was assigned by the measuring laboratory to multiple samples. These were often reported with suffixes to the main sample number (e.g., a, b). Where this is not obvious, we have added a suffix to the individual record in the PARD.

2.2 | Result (CRA)

The conventional radiocarbon age (CRA) is the measured ^{14}C value corrected for isotopic fractionation and calculated using the conventions outlined initially by Stuiver and Polach (1977) (this is a distinct value from the measured radiocarbon age, which is reported in publications prior to the late 1970s). The CRA is expressed as years BP (i.e., before present, where present is AD 1950). All CRAs measured by the Waikato Radiocarbon Dating Laboratory have been cross-checked against the laboratory's in-house database. Radiocarbon ages measured by other laboratories have not been independently verified.

The CRA is not a direct measure of time. To obtain a calendar date, the CRA must be calibrated using a curve that adjusts for temporal and reservoir variation in ^{14}C (e.g., SHCal20 [Hogg et al. 2020], IntCal20 [Reimer et al. 2020], Marine20 [Heaton et al. 2020]). The online database does not currently include calibrated dates because calibration is an interpretive process. Moreover, protocols and corrections to convert a CRA into a calendar age continually evolve to manage both the environmental and temporal spread of the samples dated. For example, a local marine reservoir correction is required for marine and estuarine shells from each region and, in some instances, the immediate environment (e.g., Petchey et al. 2023; Reimer and Reimer 2017; Ulm et al. 2023). For terrestrial samples, the Pacific region falls into both the Northern and Southern hemispheres and the use of IntCal20 or SHCal20 as standalone calibration curves during the past may not be appropriate, as Northern Hemisphere air intrudes into the South Pacific Convergence Zone (Goodwin et al. 2014), potentially impacting terrestrial dates in the South Pacific Gyre (Hogg et al. 2020; Petchey et al. 2009). The interhemispheric gradient in ^{14}C may also impact island groups further south (Büntgen et al. 2018; Turney et al. 2016).

2.3 | Material

We have provided information on material type and taxa, where possible, based on source publications and available laboratory records. It is the submitter's responsibility, not the laboratory's, to identify samples, and consequently, the consistency of that information varies significantly across the PARD, and there are often differences between the laboratory records and various publications. Auditing this information remains a challenge.

The PARD provides, where available, a classification of the material, including whether the sample is marine or terrestrial. Charcoal or wood is identified as short-lived taxa or other short-lived elements (such as twig or seed) or is unidentified. For measurements of less commonly sampled materials, such as bone, we note whether it was from an animal or a bird. Dates on human bone are collated but are not available online. These material classifications are provided as a general guide and to allow for filtering of samples of interest. Some categories are less easy to define, for example, peat, sediment or soil samples. In these instances, it is often unclear what was specifically dated (e.g., charcoal, seeds or humin), and these are therefore classified in the PARD as 'Soil'. The classifications are likely to change over time as feedback from users enables corrections, but the original sample descriptions are also provided to allow for comparison. We recommend that any chronometric analysis of the radiocarbon data be undertaken in tandem with evaluation of the source publication(s).

Users need to consider the accuracy of material details, as these can affect the interpretation of radiocarbon dates. Specific information, such as shell taxa, twig, seed or wood, provides insights into the relationship between the dated material and the event of interest (Bayliss 2015). They can also help identify potential reservoir effects, particularly in the case of estuarine shells and animal bones with mixed dietary sources (Hajdas et al. 2021; Petchey et al. 2015). Moreover, different shell taxa typically reflect a spectrum of freshwater, estuarine and marine influences and, therefore, information about the local environment may be required for calibration (Petchey et al. 2012, 2013), while consideration of in-built age is required when evaluating the accuracy of dates (e.g., Spriggs and Anderson 1993).

2.4 | Location

The location of sites, and therefore the associated ^{14}C data, is difficult to accurately determine as the different island groups, countries, researchers and projects have used a range of classification systems. Consequently, online accessibility to primary information that enables matching of site locations is limited, even in territories or countries with a national, state or territorial schema. As a result, this initial version of the PARD takes a

FIGURE 3 | Example of radiocarbon data location from Fiji as given in the PARD. Note clustering by island rather than point location (human bone dates excluded).

largely 'island' based approach with samples located on named islands. Nunn et al. (2016) developed a database of named islands with point locations, which assisted this process. We added any locations missing from Nunn et al. (2016) to the PARD using online maps, such as Google Maps, to provide longitude and latitude coordinates for each sample. Differences in spelling, the use of local names, and variations in language remain an issue (see Nunn et al. 2016: 4-5). English is the default language of the PARD, but where possible, alternatives should be developed for future iterations of the database.

The limitations of an island-based approach are apparent through closer inspection. Figure 3, for example, shows the island of Viti Levu in Fiji. The radiocarbon measurements from Viti Levu are centred in the middle of the large island, while in reality, most dates are from coastal sites. However, samples from small neighbouring islands and named reefs are centred relatively close to their actual locations. This limitation is more pronounced on larger islands, especially around Papua New Guinea.

Larger islands presented challenges in balancing the needs of regional-scale research with those required for local-scale research. For example, although a site-coded schema exists for archaeological sites recorded in Papua New Guinea, researchers do not consistently report this information, and specific location details for many sites are unavailable. Moreover, the nature of archaeological work in Papua New Guinea has meant that samples predominantly come from larger projects that investigate clusters of sites in places such as the highlands or from coastal survey areas often associated with named bays, inlets or river systems. As a result, we grouped several sites at the same location, while approximate locations were used for more isolated sites. Administrative provinces were also recorded where possible and can be used in the future to provide clustered locations at that level.

Similarly, archaeologists working in Hawai'i have not consistently reported site numbers based on the Statewide Inventory of Historic Places (SIHP) numbering system. Some collections

of radiocarbon data, such as those from Kaua'i compiled by Carson (2005), were organised by internal regional districts or *moku*. *Moku* and the finer-scale *ahupua'a* land divisions for Hawai'i are available as GIS layers (courtesy of the Hawai'i Statewide GIS Program). Future work on refining the data from the Hawaiian Islands will be limited to centroids of the islands, *moku* or *ahupua'a*, to avoid violations of the Archaeological Resources Protection Act (ARPA) in the United States. Similarly, the Mariana Islands and American Sāmoa are also territories of the United States, so future refinements will also be limited to centroids at the village or municipality level.

Site locations for New Zealand radiocarbon ages in the ANZRD rely on the New Zealand Archaeological Association's ArchSite database (https://nzaa-archsite.hub.arcgis.com) (see, e.g., Bickler 2024). Data from the island-wide database for Rapa Nui developed by Mulrooney (2013) are also available by site location. These are imported into the online PARD but are maintained separately because of these formatting differences.

Radiocarbon ages of museum specimens, where an approximate collection location is available, may be included in island or island group settings as they become available, but should be treated separately in any analysis unless precise origin information is available.

2.5 | References

The PARD can store a maximum of two publication references for each CRA. We consider the publication to be a primary reference if it includes the author or submitter of the dated sample. In cases where the radiocarbon age is reported in a publication that did not include the original author, often as part of a summary article, book or report, we consider that publication a secondary reference. The PARD provides online links to the reference, where available. Any publicly available reference to a date allowed it to be 'permissioned' for inclusion in the PARD. Many dates are in unpublished reports, and inclusion depends on the accessibility of those data or permission from the original submitter of the sample.

Previous compilations of radiocarbon ages, often the result of island-wide or regional studies specifically interested in the identification of earliest settlement or other themes, are an important component of the PARD. Addison and Asaua (2006) and Rieth and Hunt (2008) collated dates for Manu Sāmoa and American Sāmoa, Mulrooney's (2013) definitive collection for the Rapa Nui dates, with updates added by DiNapoli et al. (2021), and Wilmshurst et al.'s (2011) examination of dates from early sites in East Polynesia are examples of publications used to assist in identifying radiocarbon ages and original sources. We advise those using the PARD and associated information in their research to access and reference the primary source publication as appropriate. However, we also ask users to reference this article in addition to the original primary publications to acknowledge their use of the PARD.

A significant proportion of the data in the PARD comes from consultancy reports rather than published academic papers. The availability of these reports varies considerably across the territories. Except for the Heritage New Zealand Pouhere Taonga Archaeological Digital Library (see Bickler and Petchey 2024; Petchey et al. 2022 for further discussion see Section 3), these reports are not typically made publicly available and do not contain academic-style, permanent online links. Legal and technical restrictions prevent such access and prevent the PARD from complying with data frameworks, such as the *FAIR* guiding principles (Findable, Accessible, Interoperable and Reusable) established by Wilkinson et al. (2016) for scientific data management, where greater openness and consistency are possible.

2.6 | Other Data

We collected a range of other data during the PARD auditing process, including site name, site type and stratigraphic information. This information is not consistently provided in the source and is not included in the online version of the PARD. Moreover, information in the original radiocarbon submission records may differ from that in published sources. The submitter's name is not published online but is recorded for internal database management purposes. Data collected during the dating process, such as the $\delta^{13}C$ measurement (whether measured or estimated) used for fractionation correction during the age calculation process (cf., Stuiver and Polach 1977), are also stored in the PARD. Some researchers have used these values as environmental indicators; however, their accuracy in this regard varies depending on the collection process and the specific instrumentation used to measure them. The PARD does not currently distinguish between different $\delta^{13}C$ measurement techniques. Other information, such as pre-treatment methodology and other quality control or dietary isotope measurements, as recommended by Millard (2014), is desirable but not routinely reported in archaeological reports and is also not currently held in the PARD. The PARD does not indicate whether the CRA was obtained via Accelerator Mass Spectrometry (AMS) or conventional ^{14}C methods, although laboratory numbers and prefixes may indicate the technique used. The primary focus of the initial release of the PARD is to refine and enhance the connection between radiocarbon dates and their archaeological contexts. Future improvements require partnerships with specific radiocarbon dating laboratories, where they are still operational, to ensure the accurate reporting of measurement data.

The PARD does not report measurements taken directly from ancestral human remains. However, the dating of human bones is an integral part of the radiocarbon database for the Pacific and has been critical to models of human settlement there (e.g., Kramer et al. 2020; Nägele et al. 2025; Oliveira et al. 2022; Petchey et al. 2014). Published ^{14}C data on human bone are still collected and maintained, as they are publicly accessible from various sources; however, they are not available in the online version of the PARD.

3 | Discussion

Shutler (1970) provided one of the earliest overviews of the dates from Pacific Island archaeological sites. Since then, more than five decades of research has been undertaken into 'chronometric hygiene' to improve the reliability of the interpretation of radiocarbon dates (e.g., Clark and Anderson 2009;

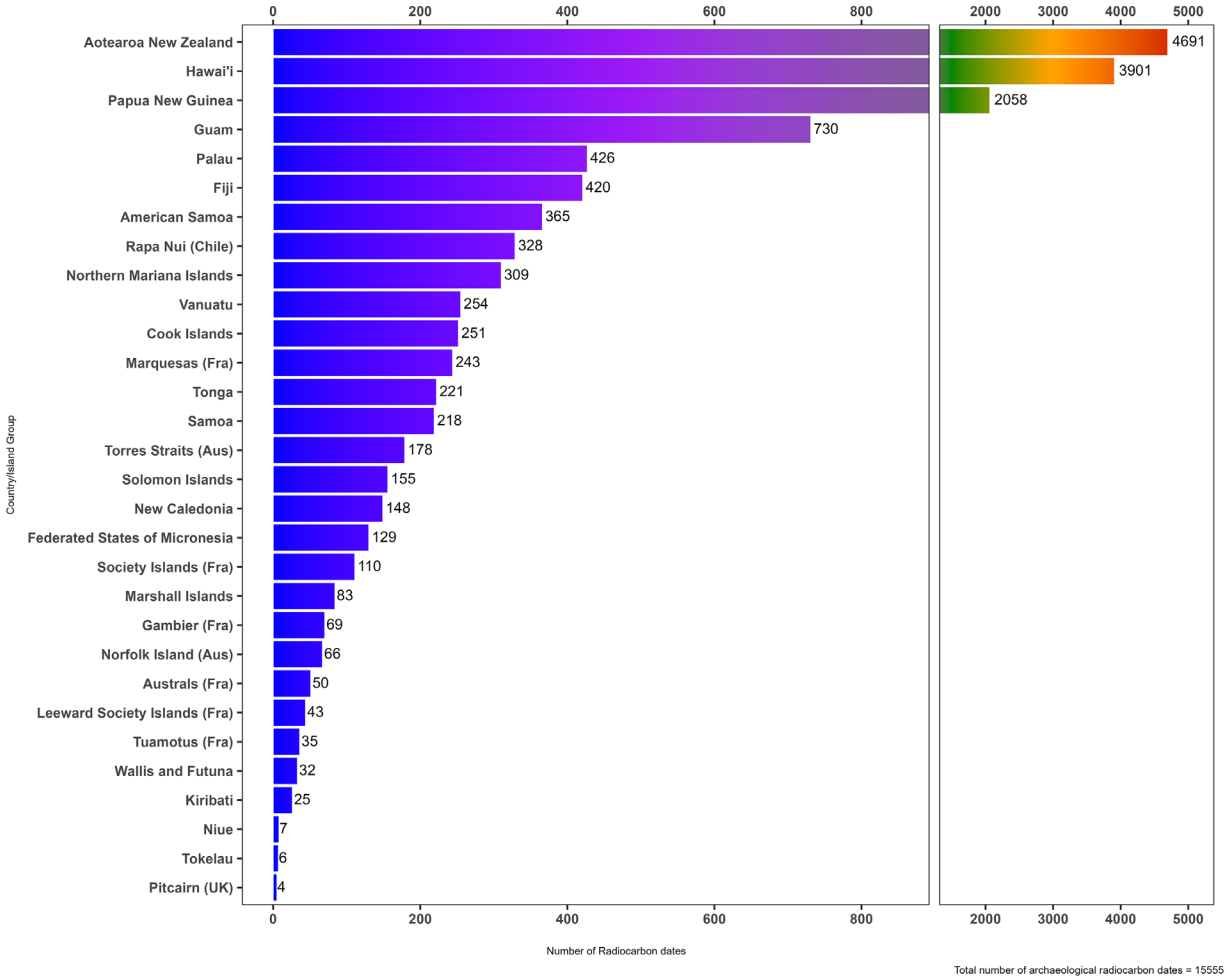

FIGURE 4 | Breakdown of archaeological radiocarbon data in the PARD by island group excluding records from human bone, South-East Asia and samples from environmental contexts (Using ggbreak from Xu et al. 2021).

Schmid et al. 2019; Spriggs 1989; Spriggs and Anderson 1993; Wilmshurst et al. 2011), but many of the issues relating to materials, stratigraphy, sample selection and interpretation seem to linger (e.g., Anderson et al. 2024). It is important to highlight, however, that major strides have been made with intensive collection strategies in many locations, resulting in significant improvements in sample selection and coverage, while substantial improvements to measurement accuracy, precision and date calibration have resulted in refinement to our interpretation of events (Burley et al. 2015; Mulrooney 2013; Petchey et al. 2018; Petchey and Kirch 2019; Rieth and Athens 2017; Schmid et al. 2019). We anticipate that the PARD will further contribute to our understanding of human endeavour in the Pacific.

The online PARD has over 17,000 radiocarbon measurements from archaeological sites (Figure 4), including those from the ANZRD. There are more than 3800 results from the Hawaiian Islands, and the total number is likely to increase as auditing of the references is still in progress. Papua New Guinea includes around 2000 measurements, and the records for West Polynesia and Micronesia are also significant, with substantial datasets from regions where cultural resource management archaeology has been undertaken over a long period, for example, Palau, Guam and American Sāmoa. The recovery of information from other locations is likely to increase the total number of dated contexts.

The PARD is not yet suitable for integration with other radiocarbon databases, such as the XRONOS *p3k14c* database, which has more rigorous sample selection and quality assurance protocols applied. In part, this is due to the unique differences encountered when conducting research in the Pacific region, including the large number of dates from non-academic sources. Moreover, site identification and location recording in areas with poor baseline geographic data require a revised set of assessment protocols.

The PARD also includes data that relates to the environmental aspects of sites or human impacts on islands. These non-archaeological dates remain part of the researchers' interest in an 'islands as landscapes' approach and the study of the effect of human migration (e.g., McConnell et al. 2021; Rehn et al. in review 2024) or the subsequent impact of natural events on human settlement (e.g., McClintock et al. 2024) and promise to provide a powerful interpretive link with archaeological dates from the Pacific. However, these dates can span the period before human arrival on the islands and should be appropriately evaluated by those using non-archaeological dates.

The PARD is a work in progress, and because auditing is still active, the database is not currently available for download. The database contains many inconsistencies reflecting the long history of radiocarbon dating in the Pacific and associated variability in the underlying data. Many results from the early use of radiocarbon dating are likely to have issues relating to date calculation, precision, contamination removal, in-built age and contextual uncertainty. While 'chronometric hygiene' protocols have demonstrated the reasons for treating such radiocarbon ages with caution, the presence of these data can still provide important information. The location of early excavations, the distribution of site types across certain broad time periods, and other such topics are useful in providing frameworks for future research (see, e.g., Bickler 2024). In some cases, material from past excavations has been stored either by the excavators or the measuring laboratory, and re-dating those sites can be helpful (e.g., Kahn et al. 2014; Mulrooney et al. 2014, 2021). However, users should be aware that inclusion within the database does not ratify the accuracy of the CRA and associated information, and that uncritical use of such legacy data may cause problems in chronology building.

Despite current limitations, the PARD remains a valuable starting point for researchers and communities in the Pacific. It has the potential to assist researchers in coordinating site location data for excavations and provides more accurate site locations for isolated island groups and past excavations than previously available. The PARD also promises to facilitate a more comprehensive investigation of key research themes, providing opportunities to identify gaps in our knowledge and open up new avenues for research. Even more importantly, the accessibility of the data online enables stakeholders, particularly indigenous groups across the Pacific, to improve their access and understanding of the value of archaeological research for their needs. Further updates to the PARD are contingent upon the Pacific archaeological community directly engaging with the authors to review existing data and make new radiocarbon data available.

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Data Availability Statement

The authors have nothing to report.

Endnotes

[1] xronos.ch: XRONOS Martin Hinz and Joe Roe at the Institute of Archaeological Sciences, University of Bern, supported by the Swiss National Science Foundation (SNSF Project #198152).

[2] Note that the values provided in the figures differ from those on the website, as the number of audited dates is regularly updated.

[3] Access to the PARD and ANZRD via the University of Waikato Radiocarbon Laboratory, Research Projects page: https://www.radiocarbondating.com.

[4] Lipo, C. n.d. A repository of radiocarbon data for Rapa Nui. https://github.com/clipo/rapanui-radiocarbon.

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