RESEARCH ARTICLE OPEN ACCESS

Maya Sequential Burials and Subsistence Change at the Prehispanic Site of Caledonia, Cayo District, Belize: The Radiocarbon Evidence

Asta J. Rand[1] | Jan Romaniszyn[2] | Jaime J. Awe[3] | Julie A. Hoggarth[4] | Richard Madgwick[1]

[1]School of History, Archaeology and Religion, Cardiff University, Cardiff, UK | [2]Faculty of Archaeology, Adam Mickiewicz University in Poznań, Poznań, Poland | [3]Department of Anthropology, Northern Arizona University, Flagstaff, Arizona, USA | [4]Department of Anthropology & Institute of Archaeology, Baylor University, Waco, Texas, USA

Correspondence: Asta J. Rand (asta.rand@gmail.com)

Received: 26 May 2025 | **Revised:** 11 August 2025 | **Accepted:** 18 August 2025

Funding: This work was supported by UK Research and Innovation (EP/YO239X/1) and Uniwersytet im. Adama Mickiewicza w Poznaniu (DEC-36/Warch/2024).

Keywords: absolute chronology | bundled burials | prehispanic Maya archaeology | secondary burial | stable isotope analysis

ABSTRACT

From the Late Preclassic to Terminal Classic periods (300 BCE–900 CE), the Maya people at the site of Caledonia, Cayo District, Belize, interred their dead within site architecture. Four burials containing the remains of at least 21 individuals were uncovered during excavations and were relatively dated using typologies developed from the ceramics recovered from the burial contexts. The single older adult female who may have been bundled in Burial 5 was dated to the Late Preclassic (250 BCE–250 CE) and was determined to be the oldest at the site. Burial 1 contained the remains of eight adults and one child interred from the Early Classic to the beginning of the Late Classic periods (450–650 CE) and is thought to be a sequentially used family tomb. Burials 3 and 4 were both buried during the Late Classic (600–900 CE), although the latter appears to be a sequentially used family tomb like Burial 1 and the former appears to be a nonfunerary ceremonial context possibly containing the remains of bundled or secondary burials. New radiocarbon dates presented here confirm the relative chronology developed for Caledonia and reveal that Burials 1 and 4 were indeed sequentially used over several centuries. When combined with existing stable carbon, nitrogen, and sulfur isotope data, the radiocarbon dating also reveals a general decreased reliance on maize-based protein from the limestone-rich Vaca Plateau over time, which may be linked with climate trends and sociopolitical reorganization at the site.

1 | Introduction

Prehispanic Maya peoples interred their dead within site architecture rather than in spaces separate from the living (e.g., cemeteries) causing burials to be a ubiquitous find at Maya archaeological sites in what are now Mexico, Guatemala, Honduras, and Belize. Primary burials containing the remains of a single extended inhumation are most common at these sites, although variable burial types, orientations, constructions, locations, and contents reflect the diverse meanings that the dead embodied for the living (Rathje 1970; Ruz 1965; Scherer 2015, 2020; Tiesler 2007; Welsh 1988). Indeed, Maya burials containing the remains of multiple individuals have a range of interpretations depending on their contexts. The first multiple burials encountered by archaeologists were thought to contain the remains of sacrificial individuals (reviewed by Weiss-Krejci 2003; see also Welsh 1988). This remains a plausible explanation in cases where there is clear evidence for mass execution (e.g., Duncan and Schwarz 2013), a central individual is surrounded by others who died violent deaths (e.g., Wright et al. 2010), or where abnormal burial location and/or position may point to sacrifice (Cucina and Tiesler 2006; Freiwald et al. 2014). However, in other cases, it is more likely that multiple burials accumulated through complex and extended funerary practices involving reopening and sequential deposition of primary and secondary burials (Chase and Chase 1996; Freiwald et al. 2014; Healy et al. 1998; Weiss-Krejci 2003).

Establishing the chronological sequence of burials and the individuals therein can help to disentangle the function and meaning of specific multiple burials at Maya sites. Burials are usually dated using ceramic seriation, which produces high-resolution relative chronologies at Maya archaeological sites (LeCount 2018). The waxing and waning of various ceramic materials, styles, and forms are also important signifiers of sociopolitical developments and interregional interaction among the prehispanic Maya (e.g., Harrison-Buck 2023; LeCount et al. 2002). Since its inception in the 1950s, radiocarbon (^{14}C) dating has greatly contributed to Maya archaeology (e.g., Fedick and Taube 1992; Housley et al. 1991; Taylor 2000) but has only recently been applied on a large scale in this region (e.g., Arroyo et al. 2020; Hoggarth et al. 2021; Inomata et al. 2017). Importantly, radiocarbon dating human remains offers a direct means to identify burial sequences, including whether the individuals in multiple burials were simultaneously or sequentially interred (depending on the intervals between deposits).

Unusual for a minor Maya site deferential to larger influential centers, three of the four burials[1] excavated from Caledonia, Cayo District, Belize (Figure 1), contained more than one individual (Awe 1985; Helmuth 1985). Based on archaeological and osteological observations, Burials 1 and 4 appear to be sequentially used lineage tombs, whereas Burial 3 likely represents a single nonfunerary ritual event (Awe 1985; Healy et al. 1998; Rand 2023). The relative chronology for Caledonia including that of the burials (Table 1) was developed based on the seriation

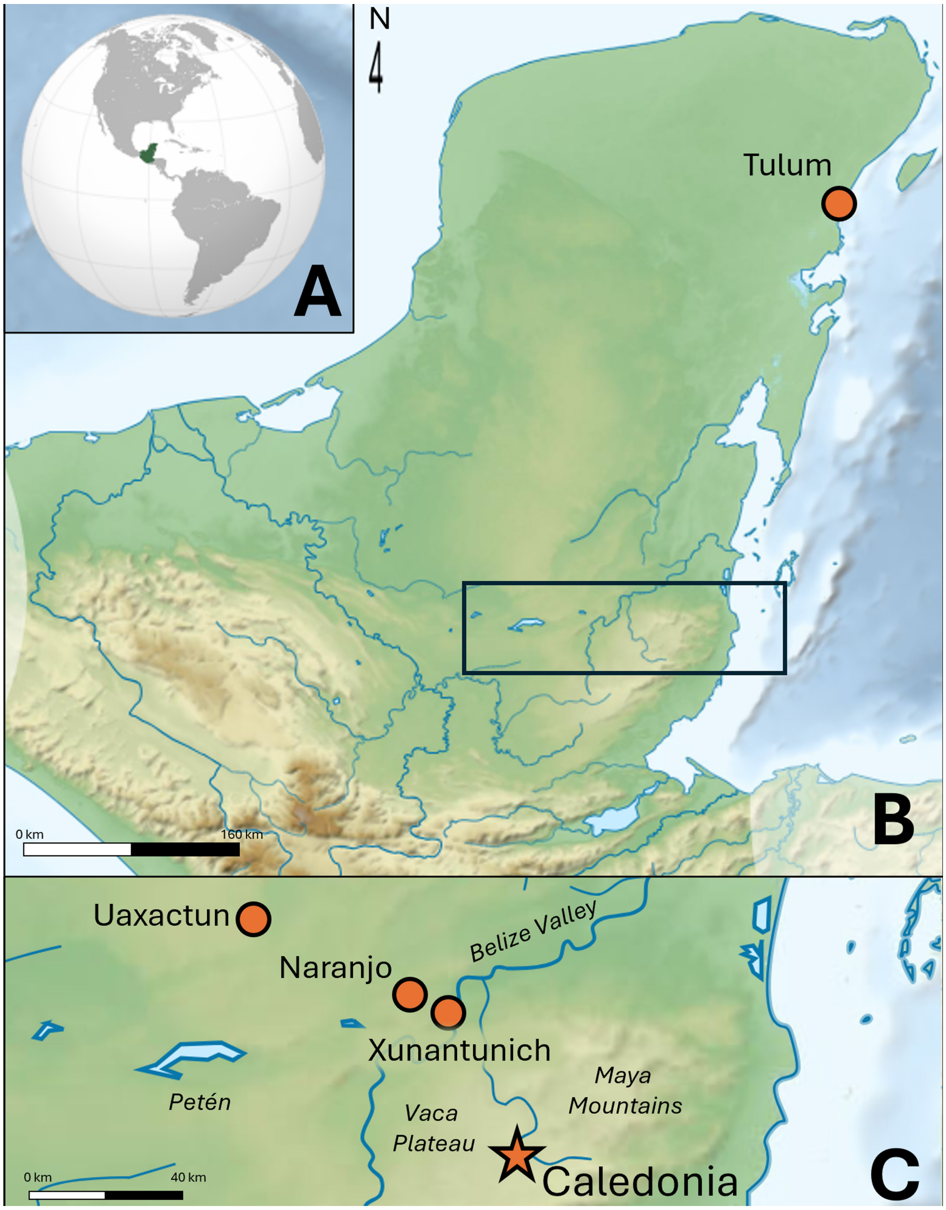

FIGURE 1 | (A) The Maya region relative to North and South America. (B) The Yucatan Peninsula (box indicates location of inset); (C) Location of Caledonia and other sites and regions mentioned in the text. [Colour figure can be viewed at wileyonlinelibrary.com]

TABLE 1 | Time periods discussed in the text and relative chronology of Caledonia developed using ceramic sequences (Awe 1985).

Time period	Phase	Time span	Associated ceramic styles/complexes
Early Postclassic	N/A	900–1200 CE	N/A
Terminal Classic	Tepeu 3	800–900 CE	Incensario subcomplexes Fine Orange (Pabellon Modeled-Carved vases)
Late Classic	Tepeu 2	675–800 CE	Spanish Lookout Complex (Benque Viejo Polychromes, Belize Red)
	Tepeu 1	600–675 CE	Saturday Creek Polychromes
Early Classic	Tzakol 3	500–600 CE	Saxche Orange Polychrome Teotihuacan style slab-footed cylinder vases
	Tzakol 2	325–500 CE	Dos Arroyos Orange Polychrome
	Tzakol 1	250–325 CE	
Late Preclassic	Chicanel	300 BCE–250 CE	Chicanel (Sierra Red, Laguna Verde Incised) Floral Park (Aguacate Orange)

of ceramics from stratified deposits at the site (Awe 1985). Understanding the chronological sequence in which each burial and the individuals therein were interred in more refined detail will greatly contribute to interpreting the development and function of these funerary spaces at Caledonia. The aims of this study are thus to verify Caledonia's relative chronology (Awe 1985), situate the burials within an absolute chronology, and characterize the sequence in which they were constructed and used. Ten bone collagen ^{14}C dates from the burials are combined with existing ^{14}C dates from two charcoal samples (Awe 1985) calibrated here against the latest curve for the northern hemisphere (Reimer et al. 2020) and stable carbon ($\delta^{13}C$), nitrogen ($\delta^{14}N$), and sulfur ($\delta^{34}S$) isotope data from the burials (Rand 2023) to better understand funerary practices and social organization at this minor Maya center.

2 | Environmental, Archaeological, and Chronological Setting

The prehispanic Maya site of Caledonia is situated 400 m above sea level on the Vaca Plateau in the Chiquibul Forest Reserve in the Cayo District of Belize. The site comprises four plaza groups arranged in two clusters covering an area of approximately 2 ha along the west bank of the Macal River (Figure 2): Plazas A and B are located to the north, whereas Plazas C and D and a ballcourt are in the southeast (Awe 1985, 94–98; Healy et al. 1998, 263–264). The Vaca Plateau itself is underlain by Cretaceous limestone that supports a broadleaf tropical forest rich in plant and animal life, much of which was managed by prehispanic Maya farmers (Johnson and Chaffey 1973, 16). In contrast, the Mountain Pine Ridge (MPR) region of the Maya Mountains to the northeast of Caledonia across the Macal River has acidic granite-based soils unsuitable for agriculture but offers economically valuable resources like granite, pine, pitch, and animals (Awe 1985). Importantly, due to geological diversity, these areas have distinct biosphere $\delta^{34}S$ values that allow migrants with outlying values to be identified (Freiwald 2020; Rand 2023; Rand et al. 2021). Combined $\delta^{13}C$, $\delta^{15}N$, and $\delta^{34}S$ values also show that some Caledonia Maya were reliant on maize-based protein from the Vaca Plateau, whereas others were more reliant on C_3-based protein sourced from the Macal River, Mountain Pine Ridge, or both (Rand 2023).

The site's relative chronology was originally developed by Awe (1985) based on the classification of ceramic materials in comparison with published examples of local and regional ceramics to identify similar complexes and phases. This was supplemented with the classification of other artifact types (e.g., groundstone, obsidian, and chert) and two radiocarbon dates (Awe 1985). These data show that Caledonia was first founded during the Late Preclassic (c. 100 CE), given the presence of Chicanel (e.g., Sierra Red, Laguna Verde Incised) and Floral Park (e.g., Aguacate Orange) ceramics and a charcoal ^{14}C date of 2010 ± 280 BP (Beta-11454; MASCA corrected to caCE 50 ± 280[2]; Awe 1985, 83) recovered from the deepest excavated levels of Structure 1 in Plaza C (Str. C-1). It is likely that Maya people strategically situated the site at that time to utilize multiple resource catchments in its surroundings (Awe 1985; Rand 2023). Caledonia continued to be inhabited through the Early Classic Tzakol 1 and 2 phases, based on the presence of Dos Arroyos Orange Polychrome vessels, during which time Str. C-1 was expanded and most agricultural terraces surrounding Caledonia were built (Healy et al. 1980). The end of the Early Classic period (Tzakol 3) witnessed the initial construction of Strs. A-1 and C-2, the expansion of Str. C-1 (Phase 4), and the leveling and plastering of Plazas A and C. Saxche Orange Polychrome ceramics and Teotihuacan style slab-footed cylinder vases were introduced and the amount of imported exotic materials like marine shell, obsidian, and jade, and exports like granite and freshwater mussel shells also increased (Awe 1985, 392). Despite this evidence for participation in interregional interaction spheres that included central Mexico and coastal regions, the $\delta^{34}S$ values of most Caledonia individuals were consistent with the local baseline and only one from Burial 4 (not included in this study) with a very elevated value may have migrated from the coast or from the Petén region of Guatemala (Rand 2023).

These developments continued at Caledonia following the transition to the Late Classic period when the size and complexity of site architecture increased, including the introduction of large, vaulted masonry superstructures on Strs. A-1 and C-1 and the

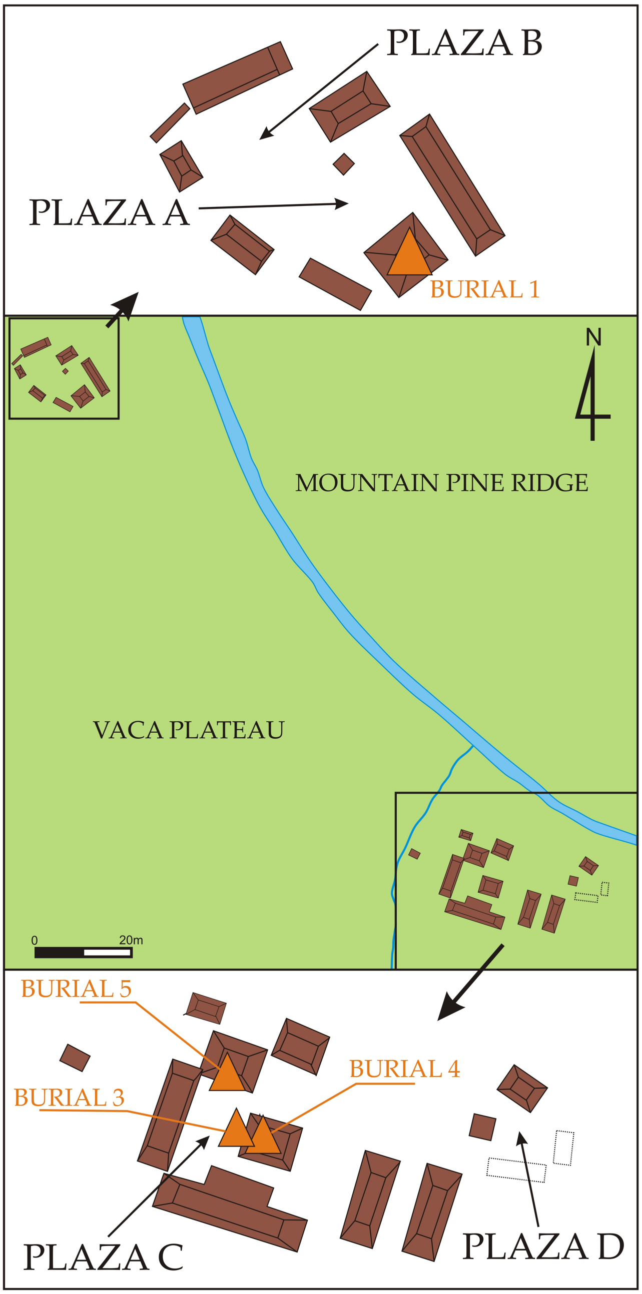

FIGURE 2 | Caledonia site plan indicating proximity to Macal River and burial locations within specific plaza groups. [Colour figure can be viewed at wileyonlinelibrary.com]

construction of a ballcourt between Plazas C and D. Interestingly, the ceramic evidence suggests this period was associated with a shift in sociocultural relationships at the site. Until the end of the Early Classic, Caledonia ceramics reflected those at large and influential sites like Uaxactun in Petén (Awe 1985, 379). However, styles from Belize Valley sites to the north (e.g., Saturday Creek Polychromes) appeared at Caledonia in Tepeu 1, likely associated with the establishment of Xunantunich as a major regional center in the Valley through that site's connections with the major Petén center of Naranjo (LeCount et al. 2002). The relations between Caledonia and the Belize Valley were solidified by Tepeu 2 with the introduction of ash or tuff as a primary tempering agent and the increasing popularity of Spanish Lookout Complex vessels (i.e., Benque Viejo Polychromes, Belize Red). Yet traces of connections with Petén sites remained in the form of modeled censers, which were popular in contemporaneous Petén but relatively absent from Belize Valley centers.

By the end of the Terminal Classic Tepeu 3 phase, Caledonia experienced an architectural fluorescence evident in the construction of stone benches in Str. C-1's superstructure and the addition of stucco friezes or facades to Strs. C-1 and C-2 that included Maya blue pigment. Ceramic evidence indicates another socioeconomic realignment at this time, as previous complexes disappeared and Petén-like materials were reintroduced to Caledonia, including Late Classic incensario subcomplexes and Fine Orange materials (e.g., Pabellon Modeled-carved vases). Such ceramics parallel those manufactured in Petén, although their pastes suggest that these vessels were not imported but rather the forms were locally adopted. This suggests that the Caledonia residents remained tied to Petén centers despite the increasing influence of nearby Xunantunich, which achieved political autonomy following the fall of Naranjo around 820 CE (LeCount et al. 2002). Local expression also comprised the development of two new types of censer lids, even as Caledonia faced abandonment at the end of this period (Awe 1985).

2.1 | The Caledonia Burials

Five burials containing the remains of at least 21 individuals were encountered during the 1980 and 1984 excavations of Strs. A-1, C-1, and C-2 at Caledonia conducted by Trent University's Trent-Cayo Archaeological Project (TCAP). Of these, 10 individuals from Burials 1, 3, 4, and 5 were available for analysis (Table 2). The burials were initially situated within a relative chronology based on aspects of the burial, including associated ceramic assemblages (Awe 1985; Healy et al. 1998; Rand et al. 2015; Rand 2023). Burial 1, an oval-shaped, vaulted crypt covered with rectangular capstones, was encountered during excavations at the summit of Str. A-1, the largest in that plaza group. The grave contained the fragmented remains of nine poorly preserved individuals, including at least one child aged 3–5 years at death and eight adults of indeterminate sex (Healy et al. 1998; Helmuth 1985; Rand et al. 2015; Figure 3). The position of the cranial bones and those of the hands and feet indicate that most were likely primary extended burials originally oriented southeast-northwest with the head to the southwest (Awe 1985; Healy et al. 1998). However, they must have been interred in succession, as the chamber was too small to simultaneously accommodate multiple fleshed bodies (Healy et al. 1998). Re-entry of the crypt is also suggested by the disarticulated and fragmentary nature of the remains, indicating that previous individuals were moved aside to allow for subsequent bodies to be interred. For example, the recovery of a metatarsal from Vessel 3, located midway along the crypt's southeast wall, indicates it was moved from its original location among the other footbones during a reopening event. The chamber was also not filled, and access to the capstones near the top of the structure would have facilitated tomb re-entry. Radiocarbon analysis of charcoal recovered from the center of the grave yielded a date of 1520 ± 120 BP (RL-146; MASCA correction 460 ± 140 calCE; Awe 1985), although the ceramics are younger, indicating it was in use between Tzakol 3 and Tepeu 2 (500–800 CE) with most dating to Tepeu 1 and 2 (600–850 CE).

TABLE 2 | Mortuary, osteological, isotopic, and radiocarbon data for the Caledonia samples (Awe 1985; Healy et al. 1998; Helmuth 1985; Rand 2023; Rand et al. 2015).

Sample ID	Burial	Age/sex	$\delta^{13}C$ (‰)	$\delta^{15}N$ (‰)	$\delta^{34}S$ (‰)	Relative chronology (CE)	Lab #	Sampled bone	Analyte[a]	^{14}C date (BP)	Calibrated ^{14}C date[b]
B1_P2	1	A?	−10.6	+7.4	+11.5	450–650	Poz-184262	Left first proximal phalanx	Bone	1515 ± 30	550–600 calCE (68.3%)
B1_P4[c]	1	A?	−4.7	+8.9	+10.4	450–650	Poz-183906	Left first proximal phalanx	Collagen	1550 ± 30	440–460 calCE (17.3%) 480–500 calCE (16.9%) 530–570 calCE (34.0%)
B1_V3	1	A?	−7.9	+9.2	+11.6	450–650	Poz-184264	Left third metatarsal	Bone	1565 ± 30	440–470 calCE (23.2%) 480–500 calCE (21.9%) 510–520 calCE (5.5%) 530–550 calCE (17.7%)
B1_SA	1	N?	−11.8	+11.6	+9.4	450–650	Poz-184265	Right femur	Bone	1405 ± 30	610–620 calCE (26.6%) 640–660 calCE (41.7%)
B3_A	3	MA M?	−12.5	+8.6	+8.1	675–800	Poz-183901	Rib	Collagen	1240 ± 30	690–700 calCE (2.9%) 700–740 calCE (30.7%) 790–830 calCE (31.7%) 860–870 calCE (2.9%)
B4_C	4	YA M?	−8.8	+10.6	+13.3	600–800	Poz-184263	Mandible	Bone	1265 ± 30	680–750 calCE (60.1%) 760–770 calCE (8.2%)
B4_F3	4	A?	−10.9	+8.6	+10.3	600–800	Poz-183902	Right fibula	Collagen	1170 ± 30	775–780 calCE (9.7%) 830–890 calCE (49.0%) 930–945 calCE (9.6%)
B4_F4	4	A?	−8.6	+9.2	+12.3	600–800	Poz-183903	Right fibula	Collagen	1335 ± 30	650–680 calCE (46.4%) 745–760 calCE (18.3%) 765–770 calCE (3.6%)
B4_F7	4	A?	−13.2	+8.5	+7.9	600–800	Poz-183904	Right fibula	Collagen	1160 ± 30	780–790 calCE (7.8%) 830–860 calCE (18.3%) 870–900 calCE (20.0%) 920–960 calCE (22.2%)
B5_A	5	OA F	−12.3	+8.6	+11.8	100–300	Poz-184275	Tibia	Bone	1815 ± 30	210–250 calCE (48.6%) 290–320 calCE (19.7%)
B1_Charcoal	1	—	—	—	—	—	RL-146	—	Charcoal	1520 ± 120	430–640 calCE (68.3%)
C1_Charcoal	Above 5	—	—	—	—	—	Beta-11454	—	Charcoal	2010 ± 280	380 calBCE–255 calCE (65.2%) 290–320 calCE (3.1%)

Abbreviations: ? = indeterminate sex, A = adult, F = female, M? = probably male, MA = middle-aged adult, N = nonadult, OA = older adult, YA = young adult.
[a]Bone = whole bone samples from which collagen was extracted by the Poznań Radiocarbon Laboratory; collagen = bone collagen extracted by Rand (2023).
[b]68.3% probability calibrated against the IntCal20 Northern Hemisphere curve (Reimer et al. 2020) in OxCal (Bronk Ramsey 2021; Bronk Ramsey et al. 2021; see Section 3).
[c]Stable isotope results are presented here for the first time.

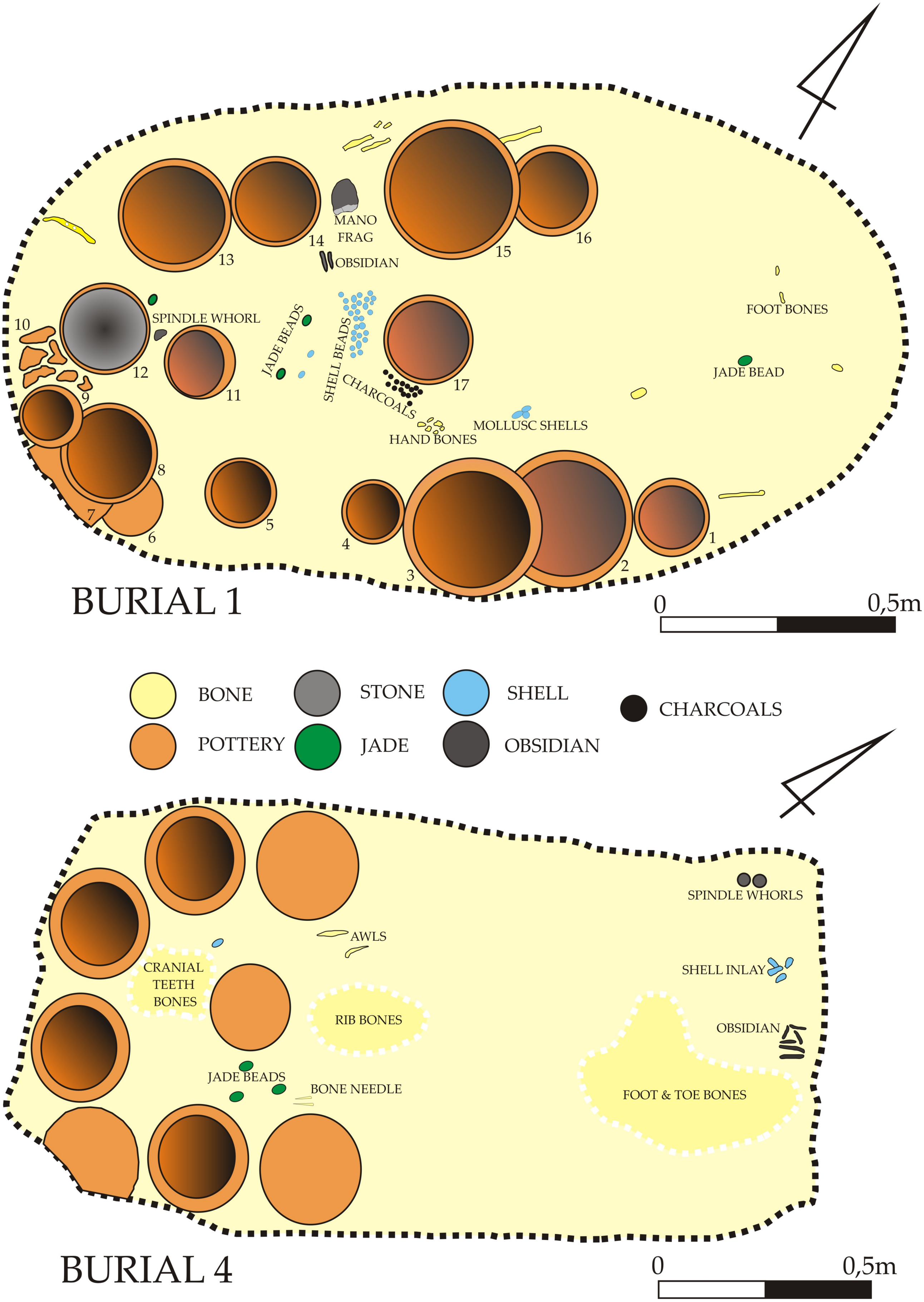

FIGURE 3 | Legend on next page.

FIGURE 3 | Plans of Burials 1 and 4 showing distribution of skeletal remains and artifacts. Vessels in Burial 1 are numbered 1–17. [Colour figure can be viewed at wileyonlinelibrary.com]

Str. C-2 is a large, well-preserved pyramidal structure located in a prominent position in Plaza C that likely was topped by a vaulted superstructure. Burial 3 was encountered below a destroyed section of the Plaza C floor and extended 1.3 m west from the base of Str. C-2 Stairway 1 following its primary axis. The skeletal remains of four individuals were recovered. Two were originally interpreted as having been seated but may instead have been bundled, given that each was positioned with the arms wrapped around the legs and the head resting on the knees. At least two other individuals were found disarticulated within a box-like arrangement of flat stones covered by a large stone disc that may have been a ballcourt marker or altar, an arrangement reminiscent of ossuaries described at other Maya sites like Tulum, Mexico (Ortega Muñoz 2022). The box was surrounded by seven miniature eccentrics, a tapered-stemmed point and obsidian core that suggest that the burial was interred and filled during Tepeu 3 and not subsequently disturbed. This context is nonfunerary (i.e., complicated contexts in Maya archaeology that contain human remains but are not formal burials; see Aimers et al. 2020, Tiesler 2007) and may be a dedicatory deposit (Awe 1985). Burial 4, a small, rectangular vaulted crypt oriented roughly north–south (Figure 3), was found below the first step of Str. C-2 Staircase 2. The crypt was originally plastered and although originally thought to contain four individuals, subsequent analysis identified at least seven (Awe 1985, 114; Helmuth 1985; Rand 2023; Rand et al. 2015). As with Burial 1, the Burial 4 individuals were highly fragmented and disarticulated; the position of the remains suggests at least some were extended northeast-southwest and the size of the tomb also indicates sequential burial. The Burial 4 skeletons were, however, better preserved than those of Burial 1, likely because the former had been filled with sandy river soil. Thus, although Burial 4 was likely also a sequentially used crypt (Rand et al. 2015; Rand 2023), it appears that it was eventually filled and no longer accessible for re-entry by the middle of the Late Classic period.

Finally, Burial 5 was a simple pit burial interred below the southern section of Floor 7 in Str. C-1 during the first of eight construction phases. It comprised a single, well-preserved skeleton of an older adult female in the flexed position laying on her left side with her head oriented to the east (Figure 4). The only grave good was a single body sherd potentially of Late Preclassic date cupped over the individual's left scapula. The burial is primary and undisturbed and so must predate the materials above Floor 7, including Late Preclassic ceramics and charcoal radiocarbon dated to 2010 ± 280 BP (Beta-11454; MASCA corrected to 50 ± 280 calCE; Awe 1985, 83). As with the "seated" individuals from Burial 3, the tightly flexed position suggests Burial 5 may have been bundled prior to burial.

3 | Materials and Methods

Ten individuals from Caledonia Burials 1, 3, 4, and 5 were strategically sampled for radiocarbon dating (Table 2). To avoid sampling the same individual twice, recurring elements in the same burial (e.g., first proximal left phalanges) were sampled when possible. Most of the differences in $\delta^{13}C$ and $\delta^{15}N$ values among individuals from the same contexts also exceed the 1.5‰ metric used to distinguish individuals isotopically (Hyland et al. 2022), indicating that separate individuals have indeed been sampled in this study. The Belizean Institute of Archaeology under the direction of Dr. Jaime Awe permitted destructive analyses, as there are no descent communities currently living near the site.

Collagen for stable isotope analysis was extracted from the samples using a modified version of the Longin (1971) method, whereby samples were demineralized (0.5 M hydrochloric acid for 14 days), hydrolyzed (70°C for 48 h), filtered (particle filters and 30-kDA MWCO ultrafilters) and lyophilized (−50°C at < 50 mTorr for 48 h) at the Memorial University Applied Archaeological Sciences (MAAS) laboratory (Rand 2023) and the Cardiff University Bioarchaeology (CUBA) laboratory, as detailed in Appendix S1 (see also Rand 2023; Rand et al. 2015, 2020). The $\delta^{13}C$, $\delta^{15}N$, and $\delta^{34}S$ measurements of B1_P4 were conducted at the Scottish Universities Environmental Research Centre using a Delta V Advantage IRMS coupled via ConfloIV to an IsoLink EA (Sayle et al. 2019). Analytical uncertainty was ±0.24‰ for $\delta^{13}C$, ±0.28‰ for $\delta^{15}N$, and ±0.89‰ for $\delta^{34}S$ as calculated according to Szpak et al. (2017; Appendix S2). The $\delta^{13}C$ and $\delta^{15}N$ measurements of the remaining samples were conducted by the Ján Veizer Stable Isotope Laboratory (University of Ottawa) using a Delta Advantage isotope ratio mass spectrometer (IRMS) coupled to a Vario EL Cube elemental analyzer (EA), but the $\delta^{34}S$ values were analyzed by the Stable Isotope Laboratory (University of Tennessee–Knoxville) on a Delta V Plus IRMS coupled to an EC S4010 EA. In both cases, analytical uncertainty could not be calculated according to Szpak et al. (2017), but analytical accuracy was ±0.07‰ for $\delta^{13}C$ and ±0.02‰ for $\delta^{15}N$ and analytical precision was ±1.00‰ for $\delta^{34}S$ (Rand 2023; Appendix S2). Only samples with acceptable collagen quality indicators (Nehlich and Richards 2009; van Klinken 1999; see Appendix S3) were selected for radiocarbon dating. The specific methods used to prepare and analyze samples and determine their quality are explained in detail in the appendices available in the Supporting Information.

Radiocarbon measurements were conducted by the Poznań Radiocarbon Laboratory on previously prepared bone collagen and bone samples prepared by the lab using a modified version of the Longin (1971) method (Brock et al. 2010; Piotrowska and Golsar 2002; see Table 2). Quality was first assessed (van Klinken 1999; Appendix S3) before radiocarbon measurements were made using accelerator mass spectrometry (AMS). The dates were calibrated based on the latest IntCal 20 curve for the northern hemisphere (Reimer et al. 2020) using OxCal 4.4 software (Bronk Ramsey 2021; Bronk Ramsey et al. 2021). The Caledonia Maya primarily consumed an isotopically terrestrial-based diet (Rand 2023; see Table 2), and so it was unnecessary

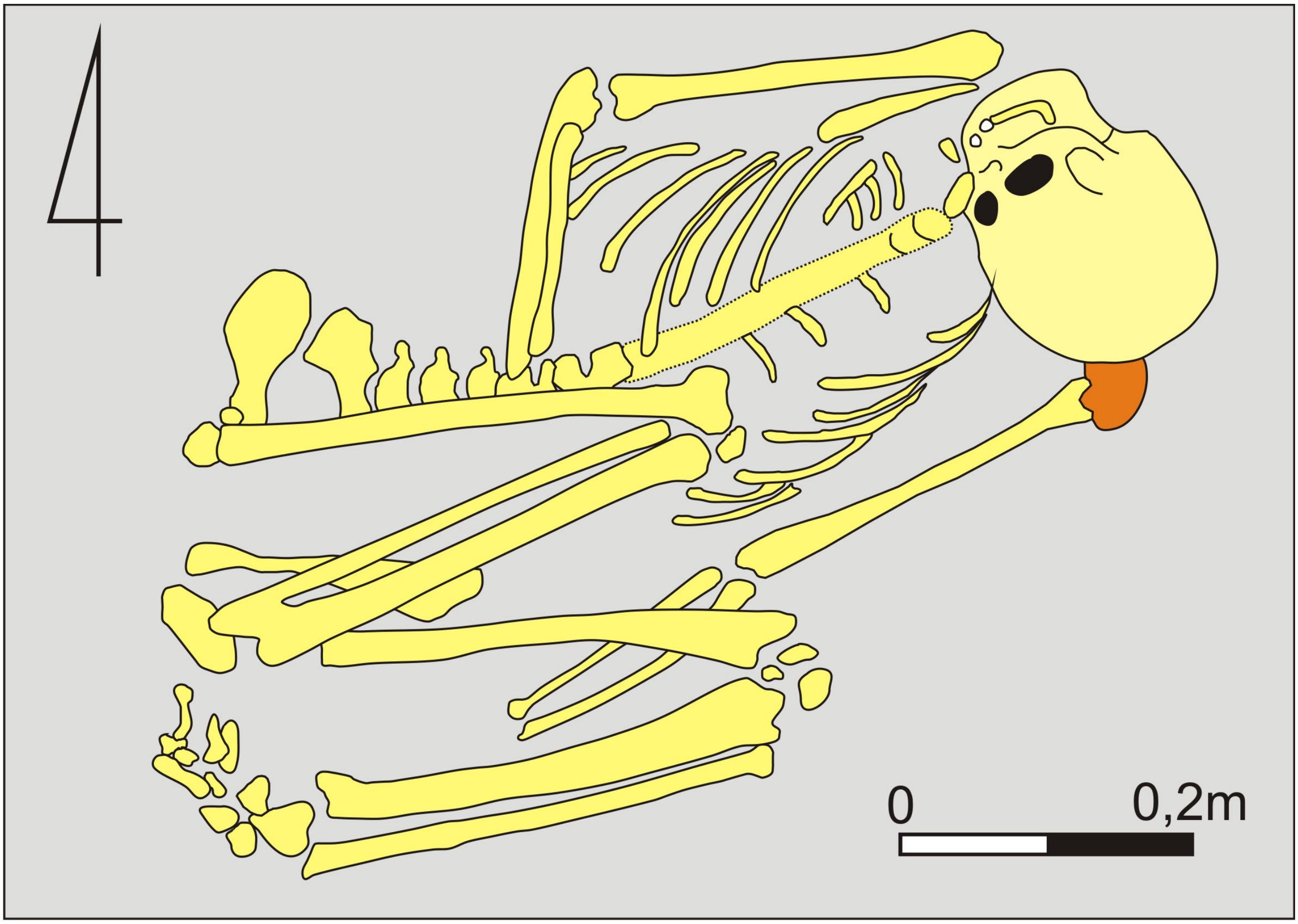

FIGURE 4 | Plan drawing of Burial 5 showing flexed position and location of ceramic fragment (in orange). [Colour figure can be viewed at wileyonlinelibrary.com]

to modify the curve with a marine or freshwater reservoir offset. Although both the 68.3% (1 sigma) and 95.4% (2 sigma) probabilities are presented in Figures 5 and 6, only the former is used in the interpretation of the results, as it is a more robust measurement of statistical uncertainty.

Due to the small sample size, extensive statistical analyses and modeling were not possible. Instead, the *sum* and *sequence* commands in OxCal were used to determine the probable periods of use for Burials 1 and 4. Due to the large errors associated with the charcoal samples, they were excluded from this analysis. The nonparametric Kendall's Tau-b correlation was used to statistically evaluate trends in the small isotope datasets over time in IBM SPSS (Version 29.0.2.0; Appendix S4).

4 | Results

The isotopic and radiocarbon results are presented in Table 2. As noted in previous studies, the elevated δ^{13}C values combined with moderate δ^{15}N values suggest all individuals consumed a maize-based diet supplemented with other plants and animal protein (Rand 2023; Rand et al. 2015). The δ^{34}S are variable but all fall within the local range (+6.6‰ to +15.6‰; Rand 2023), suggesting that individuals with higher values depended on protein from the Vaca Plateau, whereas those with lower ones sourced more protein from the Macal River or Maya Mountains.

As expected, the oldest date was obtained from Burial 5 in Str. C-1, ranging from the end of the Late Preclassic Chicanel to the beginning of the Early Classic Tzakol 1 phases (Table 2 and Figures 5A and 6). This falls at the younger end of the very broad date range of a charcoal sample recovered above the grave, which was originally corrected to 50 ± 280 calCE (Awe 1985, 83) and spans the entirety of the Late Preclassic when corrected using the most recent IntCal 20 curve (Table 2). It is worth considering how the charcoal came to rest above the grave; perhaps this sample represents the "old wood effect" whereby older wood is incorporated into a younger context (Schiffer 1986), or it may relate to another stage of the structures' use.

Burial 1 in Str. A-1 was the second oldest excavated burial feature at Caledonia with radiocarbon dates within the Tzakol 2 to Tepeu 1 range (Table 1 and Figure 6). These dates are consistent with the original ceramic chronology and charcoal radiocarbon date, which range from the mid-Tzakol 2 to mid-Tepeu 1 phases when calibrated using the most recent curve at a probability of 68.3% (RL-146, 1520 ± 120; Awe 1985). The earliest dated individual from Burial 1 was the metatarsal recovered from Vessel 3 (B1_V3; Figure 5b), followed by one of the phalanges (B1_P4;

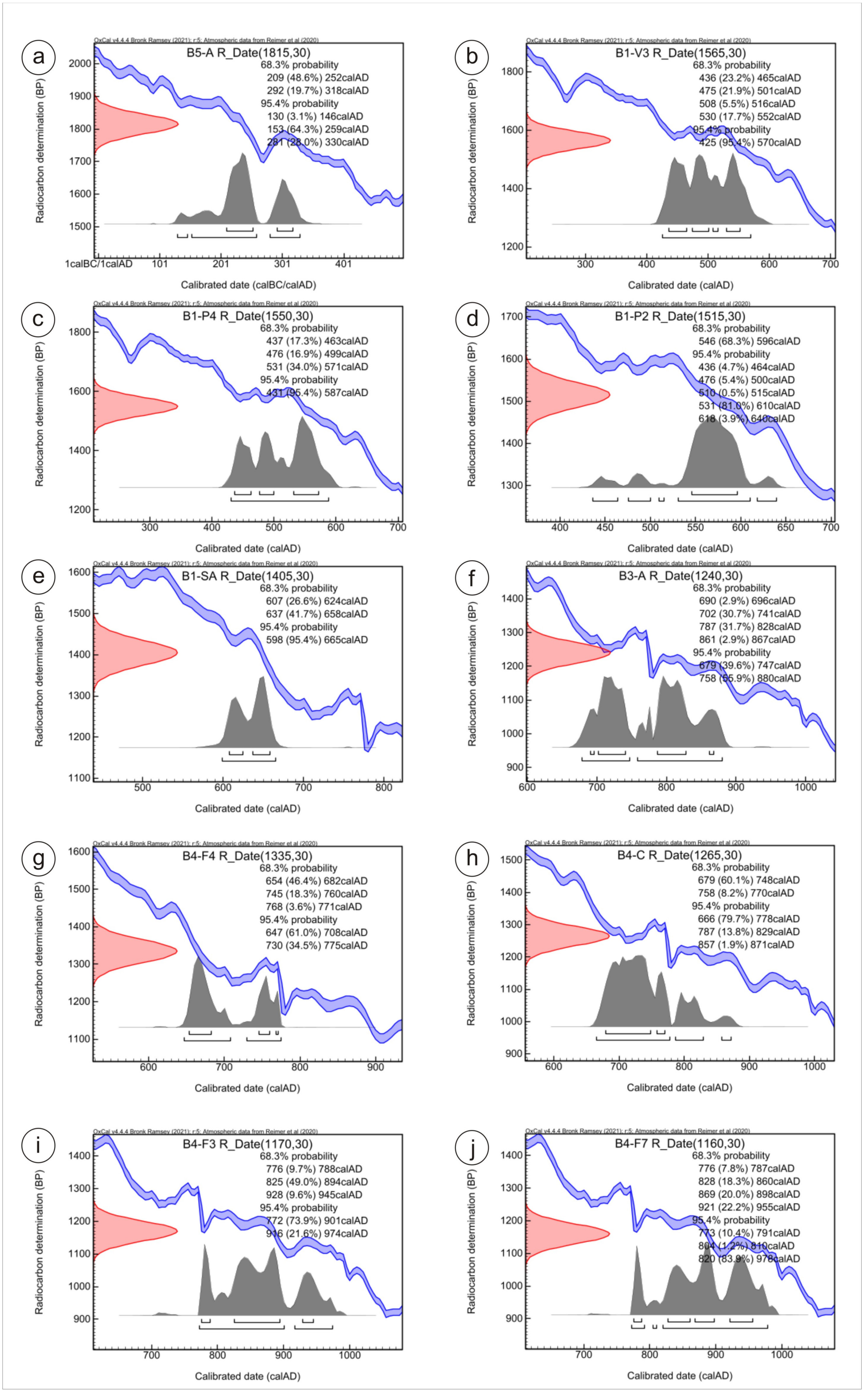

FIGURE 5 | Calibrated radiocarbon dates of the Caledonia samples. [Colour figure can be viewed at wileyonlinelibrary.com]

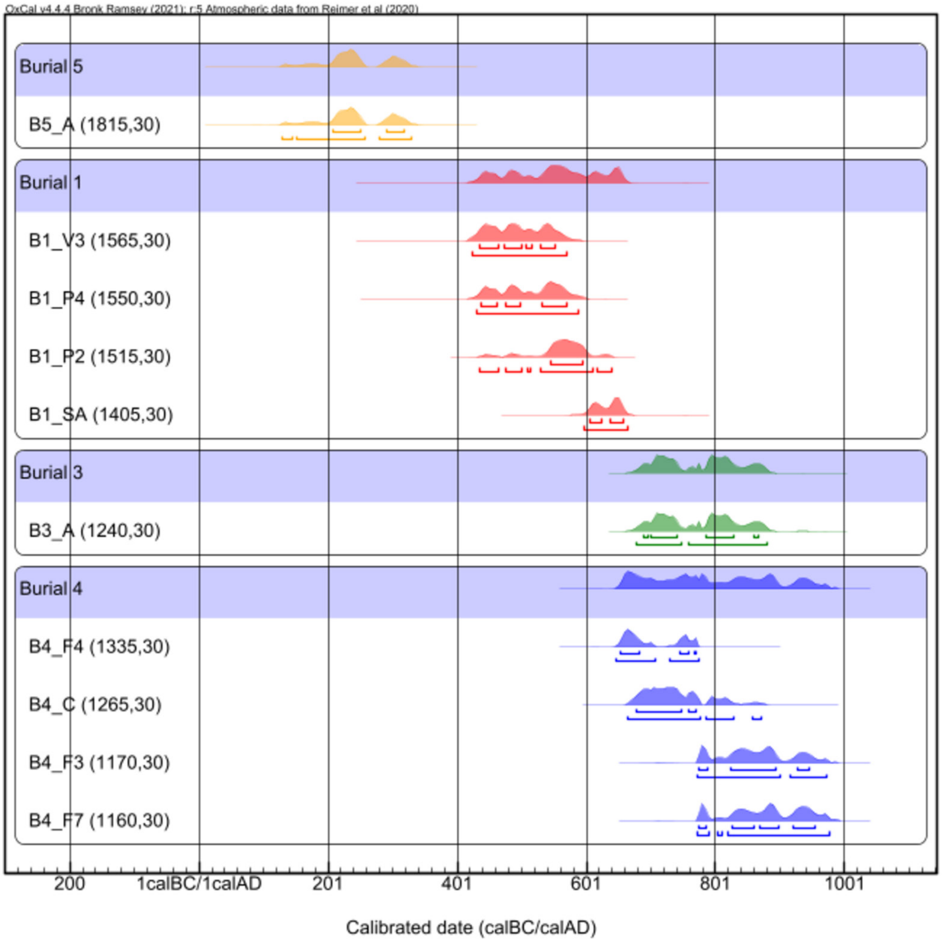

FIGURE 6 | Calibrated radiocarbon dates of the Caledonia burials by burial context showing dates of individuals and span of use for each burial. *Note:* All ranges are at 63.8% probability (Bronk Ramsey 2021). [Colour figure can be viewed at wileyonlinelibrary.com]

Figure 5c), both of which date from Tzakol 2 to 3. The second phalanx (B1_P2) is slightly younger, dating only to Tzakol 3 (Figure 5d). A definite outlier is the child's femur (B1_SA), which is over a century younger than the other Burial 1 samples (Figures 5e and 6). Despite the older metrics of the radiocarbon dated charcoal from this context (Awe 1985), its revised calibration is consistent with the results presented here. These data clearly show long-term usage of Burial 1 from the 5th to 7th centuries CE and sequential interment over a period of at least 200 years (Figure 6).

The context of Burial 3 indicates that all four individuals were interred during a single event. Among them, one was radiocarbon dated (B3_A, Poz-183901; Figure 5f), suggesting this occurred during the Late Classic Tepeu 2 to 3 periods. The youngest Caledonia ^{14}C dates were obtained from Burial 4, represented by four individuals (Figure 6). Like Burial 1, these suggest sequential use of the funerary space, although Burial 4 was in use for a longer period of about 250 years from the middle of the 7th to the first half of the 10th centuries CE. Fibula 4 was interred during Tepeu 2 (Figure 5g) and slightly predates the Burial 3 individual. This is followed nearly half a century later by the burial of Individual C from Tepeu 2 to 3 (Figure 5h) and Fibulae 3 and 7 during Tepeu 3 (Figure 5i,j). Although the latter are almost contemporaneous, they indeed represent separate individuals given that both nearly complete right fibulae produced $\delta^{13}C$ and $\delta^{34}S$ values more than 1.5‰ apart (Table 2; see Hyland et al. 2022), suggesting that the Fibula 7 individual consumed less maize-based protein and originated from an area closer to the Maya Mountains than the Fibula 3 individual (Rand 2023).

When existing $\delta^{13}C$, $\delta^{15}N$, and $\delta^{34}S$ data (Rand 2023; Rand et al. 2015) are compared according to their ^{14}C measurements using Kendall's Tau-b (Appendix S4), several interesting chronological trends become apparent (Figure 7). The only individual from the Preclassic period has a lower $\delta^{13}C$ value and higher $\delta^{34}S$ value relative to the Early Classic individuals from Burial 1 (Table 2), suggesting that maize-based protein from the Vaca Plateau increased in importance during the first half of the Classic Period. However, there is a statistically significant decrease in the adult $\delta^{13}C$ values throughout the Classic period ($\tau\_b = -0.571$, $p = 0.048$, $n = 8$). Although the $\delta^{34}S$ values are not significantly correlated with time ($\tau\_b = -0.289$, $p = 0.245$, $n = 10$), the Late Classic $\delta^{34}S$ values were significantly positively correlated with both $\delta^{13}C$ values ($\tau\_b = 0.800$, $p = 0.050$, $n = 5$) and $\delta^{15}N$ values ($\tau\_b = 0.949$, $p = 0.023$, $n = 5$). Although the sample size is small, this suggests that throughout the Classic period the consumption of maize-based protein obtained from the Vaca Plateau reduced and reliance on lower-trophic level protein sourced from areas like the Maya Mountains or Macal River increased.

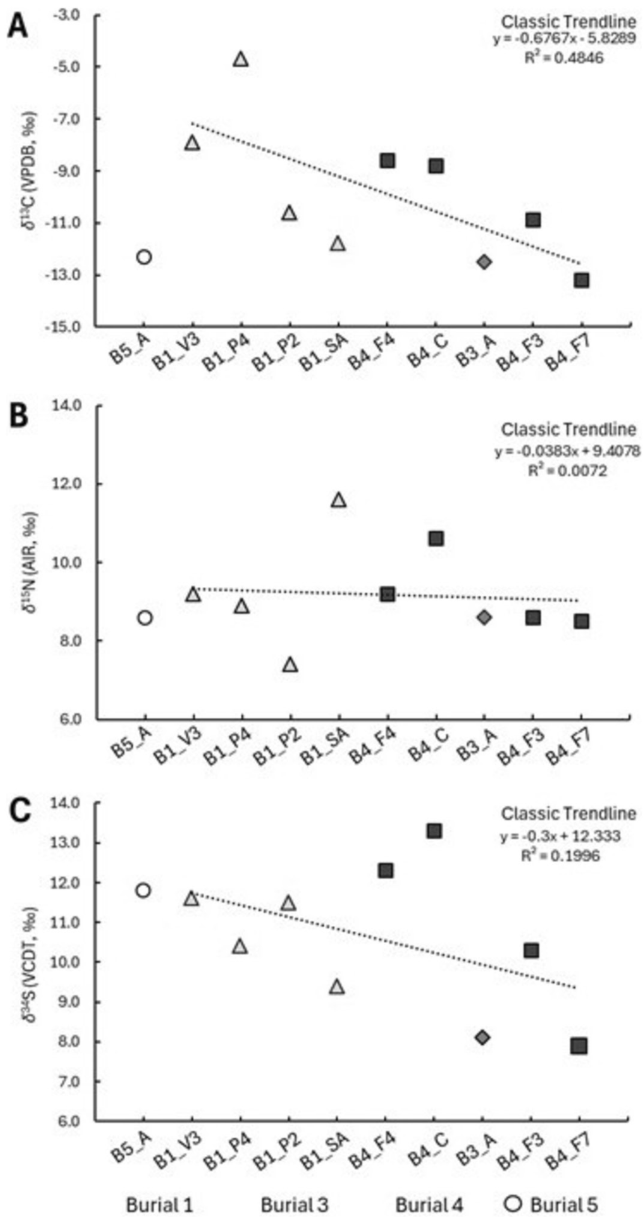

FIGURE 7 | Existing (A) $\delta^{13}C$, (B) $\delta^{15}N$, and (C) $\delta^{34}S$ data for the Caledonia individuals arranged chronologically based on ^{14}C measurements obtained in this study.

5 | Discussion and Conclusions

The radiocarbon dates from the Caledonia burials are in excellent agreement with the original ceramic chronology, yet, in combination with archaeological and stable isotope data, provide new insight into burial practices and diet at the site. The absolute chronology developed from the ^{14}C data indicates that the Caledonia funerary features were in use from at least the 3rd to the middle of the 10th centuries CE, and five periods of funeral activity can be distinguished. As expected, Burial 5 was the oldest at the site, having been interred during the 3rd to 4th centuries CE. This Preclassic individual also clearly had a distinct diet comprising less maize-based protein obtained from the immediate surroundings of the site relative to later Classic period burials at Caledonia. The second phase comprises individuals in Burial 1 interred from the second half of the 5th century to the first half of the 6th century CE, followed by a third period of funerary activity wherein the Burial 1 child was interred in the first half of the 7th century CE. The fourth stage corresponds to the earliest individual interred in Burial 4 during the middle of the 7th to 8th centuries CE. The final stage comprises the remaining individuals from Burial 4 and one from Burial 3, who were interred during the first half of the 8th to the beginning of the 10th centuries CE.

Two of the burial contexts may contain the remains of bundled or secondary burials: the tightly flexed older adult female in Burial 5 and the seated and disarticulated individuals in Burial 3. Radiocarbon and archaeological data from Burial 3 indicate that it was interred in a single event at the end of the Late Classic period. However, the arrangement of the remains and intrusive nature of the burial suggests that it may represent protracted funerary practices involving secondary burial. If so, the date from Individual A may not accurately reflect those of the other three Burial 3 individuals, who should be independently dated in the future. Similar to the "old wood effect," individuals in secondary burials may predate the construction of their final resting place by several decades to centuries, and so the archaeological context must be carefully considered when interpreting radiocarbon results.

As previously proposed (Healy et al. 1998; Rand 2023), the radiocarbon evidence shows that both Burials 1 and 4 were sequentially used tombs that were reentered at least once in antiquity. Burial 1 experienced at least three discernible entry events. The two earliest dated individuals were interred from Tzakol 2 to 3 and were disturbed by subsequent activity in the grave, as evidenced by a metatarsal being recovered from Vessel 3 rather than with the other bones of the feet. Another entry occurred during which the third dated individual was interred in Tzakol 3. This suggests that the tomb was primarily in use during the Early Classic when Caledonia showed stronger ties with Petén centers. Although the burial ceased to be sequentially used in the latter half of that period, ceramics recovered from the masonry room on the summit of the structure suggest it continued to function until the site was ultimately abandoned in the Terminal Classic period (Awe 1985, 48). Following a political realignment at the turn of the Late Classic during Tepeu 1, which saw a strengthening of relationships between Caledonia and sites in the Belize River Valley like Xunantunich, Burial 1 was reopened to inter the remains of a child. Given that the remains of children may signify nonfunerary caches and offerings rather than burials at Maya sites (Becker 1993), perhaps the tomb was re-entered to inter the child's remains as part of a termination event signifying the discontinuation of the tomb or the lineage buried within. Interestingly, most ceramics from Burial 1 date to between 600 and 800 CE and may have been deposited during a reentry event such as the one during which the child or perhaps an undated individual within Burial 1 was interred.

The ^{14}C results confirm that both Burials 1 and 4 were sequentially used tombs, and the individuals within appear to have consumed less maize-based protein from the ^{34}S-enriched Vaca Plateau over time. The Burial 1 child had an elevated $\delta^{15}N$ value indicative of breastfeeding (Rand 2023; Rand et al. 2015). Maize consumption was higher among the Burial

1 individuals relative to the Preclassic individual from Burial 5 and the later Classic period individuals from Burials 3 and 4. Although the sample sizes are small, this suggests that maize consumption initially peaked after the transition from the Late Preclassic to the Early Classic periods and then decreased throughout the Classic period. Extensive terracing of the area surrounding the site in the Late Classic may represent an attempt by local Maya communities to maximize maize-based agriculture in the face of increasing scarcity of this crop from the Early to Late Classic periods. Indeed, climatic studies of lake sediments across the Yucatan Peninsula have identified increasing aridity during the Classic period that culminated from the Late Classic to Early Postclassic periods (Douglas et al. 2016) and would have had a negative impact on maize-based agricultural practices. As has been observed at Cahal Pech during the transition from the Late Preclassic to Early Classic periods (Ebert et al. 2019), the stable isotope evidence suggests that the Caledonia Maya utilized the broad subsistence base available near the site to supplement their diets in the face of climate instability.

Diet is, however, strongly linked with identity (Hastorf 2017), and so the decreasing reliance on maize over time at Caledonia could also represent an ideological shift accompanying a sociopolitical realignment that emphasized relations between Caledonia and Belize Valley sites rather than those in Petén during the Late Classic. This is evident in the Caledonia ceramic assemblage, which closely resembled those from sites in Petén, Guatemala, until the end of the Early Classic, after which Late Classic ceramics more closely reflect those of Belize Valley sites like Xunantunich (Awe 1985). This also supports the previous hypothesis that with this change in political alignment, the Caledonia Maya may have shifted focus away from the lineage buried in the Early Classic Str. A-1 tomb (Burial 1) to the lineage interred in the Late Classic sequentially used tomb in Str. C-2 (Burial 4).

5.1 | Limitations and Future Research Directions

Overall, the radiocarbon results confirm the relative chronology developed for Caledonia and shed new light on temporal trends in subsistence practices when combined with existing stable isotope data. Several limitations associated with this research should, however, be acknowledged. First, the skeletal sample size is very small ($N = 22$) and the sample of radiocarbon dates was even smaller ($N = 10$), limiting the types of conclusions that may be drawn from the data. Secondary and bundled burial contexts of earlier individuals reburied in later contexts also pose unique challenges for radiocarbon studies similar to the well-documented "old wood effect." Ongoing analysis of strontium isotope ($^{87}Sr/^{86}Sr$) ratios in both teeth and bone may help interpret such a complex context at Caledonia by revealing whether the Burial 3 individuals moved during life or were relocated after death. Future ^{14}C analysis of the remaining individuals from Caledonia will no doubt refine the absolute chronology and interpretations presented here and a wider suite of isotopic measurements including $^{87}Sr/^{86}Sr$ would shed more light on food catchment and mobility, allowing the development of more extended models of the precise chronological frames within which the site was used.

Acknowledgments

We like to thank Prof. Paul Healy and Trent University's Department of Anthropology for their continued support of the Caledonia research. We would also like to thank Dr. Kerry Sayle for assistance with isotope analysis and Prof. Tomasz Goslar and Dr. Robert Staniuk for assistance with radiocarbon analysis and modeling. This research was financially supported by UKRI and MSCA (AR; Ref. no. EP/YO239X/1) and the Faculty of Archaeology at Adam Mickiewicz University in Poznań (JR; Project no. DEC-36/Warch/2024). We also thank the Belize Institute of Archaeology for their support of the excavations at Caledonia and for providing permission to conduct destructive analyses of the human remains.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available in the Supporting Information of this article.

Endnotes

[1] Five Caledonia burials were identified, but Burial 2 comprises a nonfunerary dedicatory cache containing the remains of a single nonadult (see Becker 1993) and so is not considered here.

[2] Originally corrected using the MASCA (Museum Applied Science Center for Archaeology) calibration curve (Ralph et al. 1974) and reassessed in this study (Table 2).

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Supporting Information

Additional supporting information can be found online in the Supporting Information section. **Appendix S1:** Collagen extraction methods. **Appendix S2:** Standard uncertainty. **Appendix S3:** Collagen quality criteria. **Appendix S4:** Results of the statistical analyses.