**Supplemental Material**

# An 18 ka to present pollen- and phytolith-based vegetation reconstruction from Hall's Cave, south-central Texas USA

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## Contents

## 1. Modern pollen and phytolith assemblages

The pollen trap installed in the interior of the cave collected considerably fewer pollen grains (50 counts) than the one at the cave entrance (288 counts). However, the entrance trap collected fewer spores (51 counts) than the interior one (148 counts) (Appendix: Table S1). Neither trap collected charcoal, which is relatively abundant in the modern surface sample (Fig. S1a). In the three modern samples (surface and two traps), the frequencies of arboreal pollen are considerably greater than the non-arboreal pollen (Fig. S1a). The two most abundant taxa present are *Quercus* (oak) and *Juniperus* (juniper), followed by Asteraceae (Aster family) and Pooideae (grasses) (Figs. F5b-5c). *Pinus* (pine) is absent in the pollen traps, but all the other arboreal taxa appear in similar proportions for all three samples.

Phytoliths recovered from the pollen traps had variable, but significant counts (Appendix, Table S2). Phytolith assemblages from the two traps were compared with those of the uppermost sample (Fig. 3: modern surface at +5 cm) inside the cave and a sample from the soil surface outside the cave (Fig. S2). The proportions of phytolith groups is similar among the four samples, with the blocky type being more prominent in the modern soil surface (Fig. 6a). The different phytolith morphotypes produced by the Poaceae have also similar distribution among the four samples (Fig. 6b). However, the short cells frequencies in the two trap samples are much higher (>75%) than the other two samples.

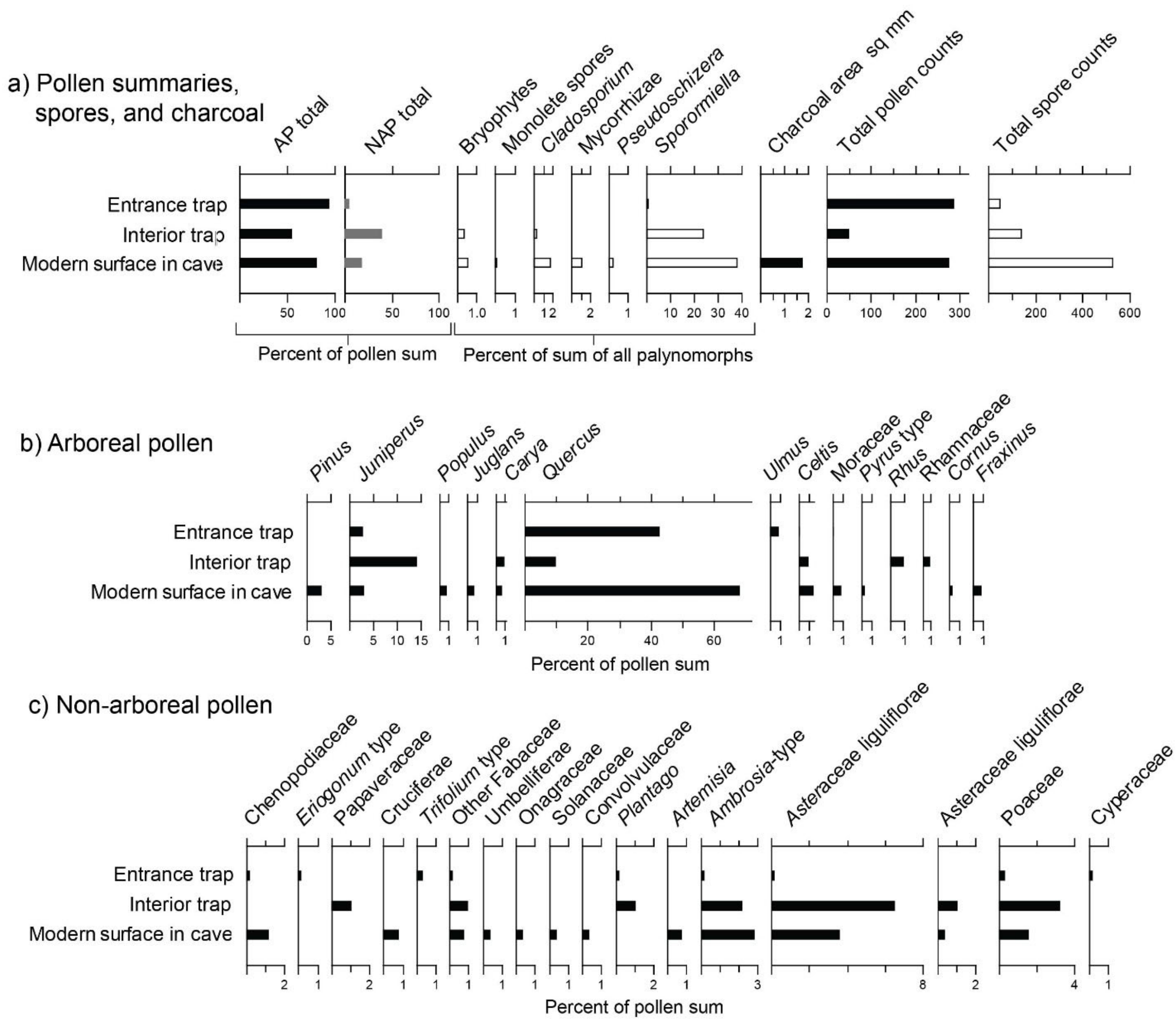


Fig. S1 Modern pollen spectra from traps and sediment surface inside the cave.

The distribution of grass silica short-cells (GSSC) in all four modern samples shows the predominance of morphotypes typical of the $C_4$ grasses, which today are abundant in the area, with a slightly larger proportion of Chloridoideae saddles in relation to Panicoideae bilobates and crosses (Fig. S2c). The long-shank bilobates, typical of the Aristidoideae are relatively abundant, which is consistent with the abundance of *Aristida* grasses in in the heavily grazed, modern landscape around the cave. The distribution of frequencies of $C_3$ (Pooideae) diagnostic short-cell morphotypes appear similar among the four samples, except in the case of the *Stipa*-type bilobates (i.e., trapezoid bilobates), which are considerably more abundant in the two trap samples (Fig. 6c).

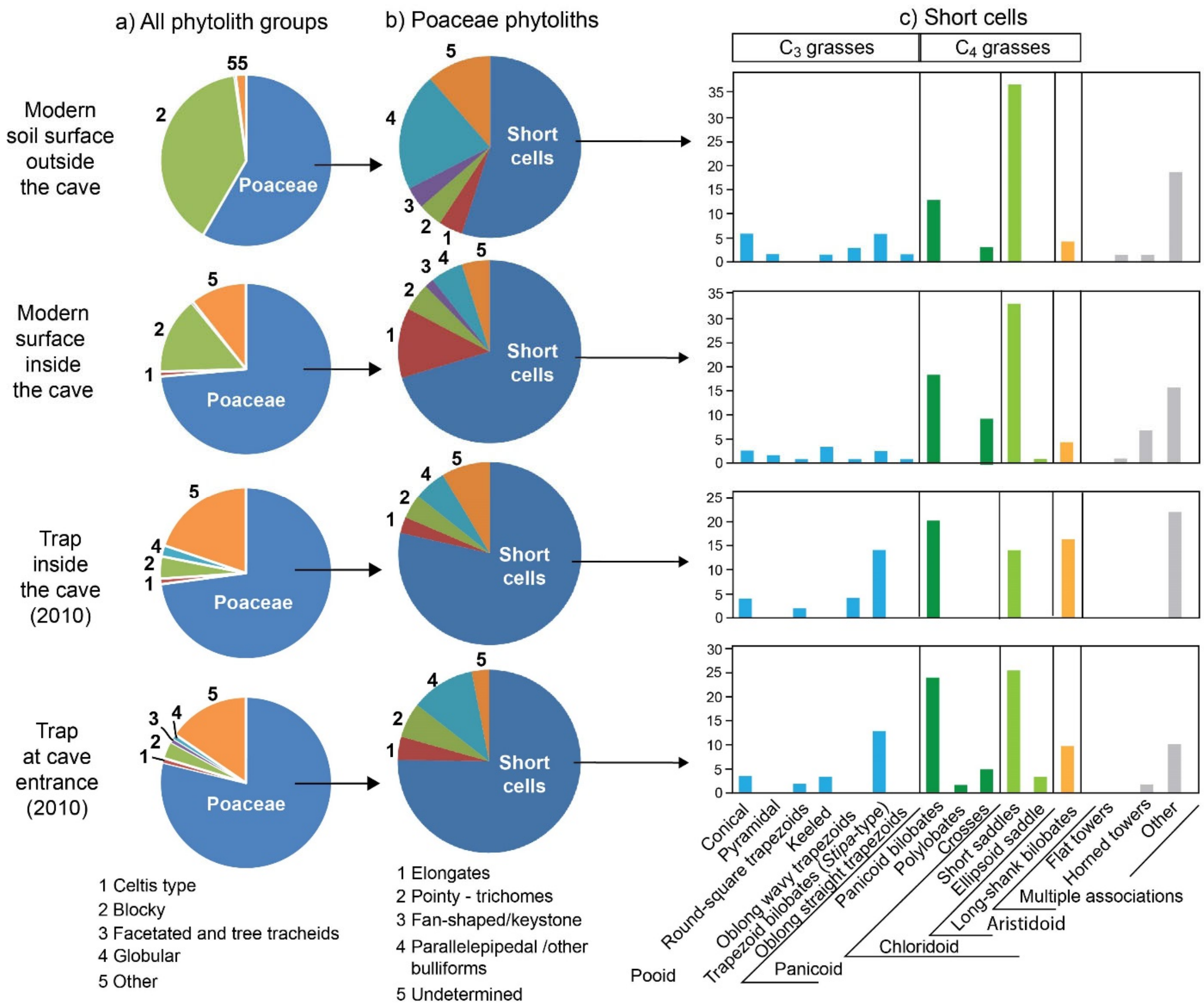


Fig. S2 Modern phytolith spectra from modern traps.

## 2. Age Model data and graph and sedimentation rates

Radiocarbon dates (Appendix, Table S3) were originally published by Cooke et al. (2003). They were calibrated using the Bacon v.22 program. The results by depth are presented in Appendix (Table S3), and the model is displayed in Fig. S3 with marks indicating the extent of the stratigraphic units (See Fig. 3 in manuscript). Based on this model, sedimentation rates were calculated (Table S4 Appendix), and displayed as a bar graph in Fig. 10 of the main manuscript.

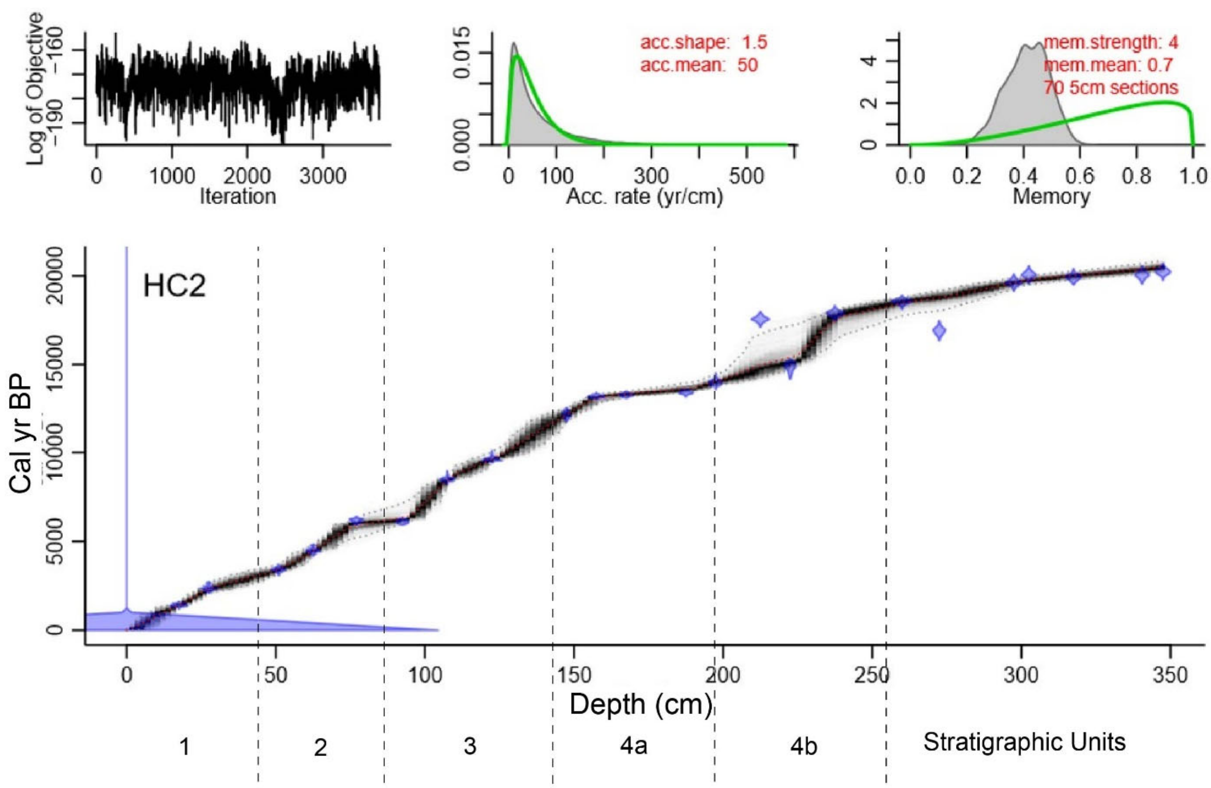


Fig. S3. Age model using Bacon v. 2.2.

## 3. Pollen, spores, other palynomorphs, and charcoal counts

Pollen and spore counts and charcoal concentration are in separate tables. Pollen and spore counts appear in Table S4 (Appendix). Percentages (frequencies) of pollen were calculated based on the total pollen sum. Percentages presented in the graphs of Figures 5 and 6 (main article) include only selected taxa, usually the ones with most counts, or those of climatic importance.

Spores are very abundant. Therefore, they were estimated based on the total sum of palynomorphs (pollen, spores, algae, etc.). This includes the fungal coprophile spore *Sporormiella*. In the article, data appears in Fig. 4. However, for purposes of discussion of developments during the the Pleistocene-Holocene transition, see section 6 of this supplemental document

The calculation of charcoal concentration is described in the Methods section in the main paper. The concentration values are presented as area in mm per gram of sediment. Data are presented in Table S7 in the Appendix. See also discussion on charcoal concentrations during the Pleistocene-Holocene transition in section 6 of this supplemental document.

**4. Principal Component Analysis (PCA) data and graph**

PCA was calculated using PAST 2.17 software (Hammer and Parker 2006). Given the disturbance caused by livestock, the modern sample was not included in the analysis. For this analysis, the following taxa were included: *Pinus, Picea, Juniperus, Salix, Quercus, Juglans, Carya, Ulmus, Celtis*, Moraceae, Rhamnaceae, *Alnus, Fraxinus, Ephedra*, Poaceae, Amaranthaceae, *Eriogonum, Opuntia*, Umbelliferae, Onagraceae, *Salvia*-type, *Ambrosia, Artemisia*, Asteraceae tubulifloreae, and Asteraceae liguliflોreae.

Eigenvalues and percent of variance for PC axes are listed in Table S5. In the same table the PC loadings by age are listed. The distribution of such loadings for PC1 and PC2 axes by age and pollen zone are presented in the graph of Fig. S4. The distribution of loadings are presented in Fig. 7a and the distribution of individual taxa in the diagram are presented in Fig. 7.b.

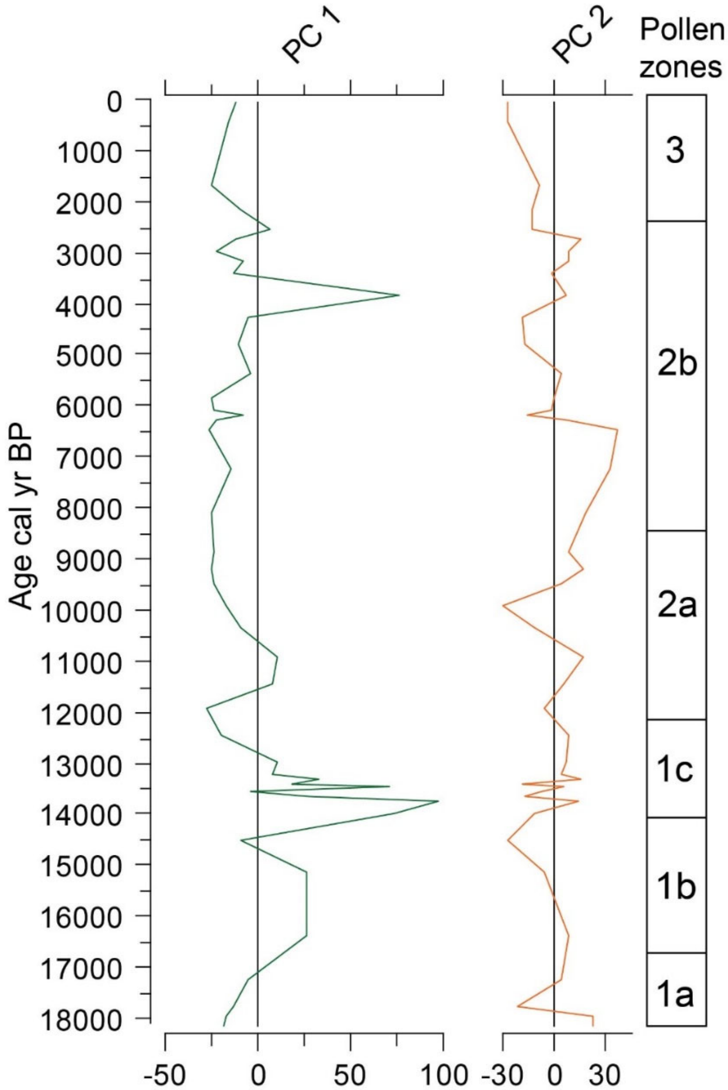


Fig. S4. PC1 and PC2 from the principal component analysis, with pollen zones.

## 5. Total phytolith counts and GSSC counts and ratios

The data presented on Figure 8 in the main paper are frequencies based on individual counts of grass and non-grass phytoliths (Table S9, Appendix), and presented in Fig. 8 in the main article. Frequencies of diagnostic grass short-cell silica (GSSC) phytoliths are calculated from the total counts of the diagnostic GSSC groups (Table S 10, Appendix) and the results presented in Fig. 9 of the main manuscript. Each ratio is calculated as follows:

$$C_3/C_4 \text{ ratio} = (\text{Pooid}/\text{Panicoid}+\text{Chloridoid}+\text{Aristidoid}) \times 100$$

$$\text{Panicoideae/Chloridoideae ratio} = (\text{Panicoid/Chloridoid}) \times 100$$

## 6. Taphonomic aspects of the plant microfossil record in Hall's Cave

*Cave sediments and the microfossil record*

It is easy to assume that most pollen grains may have made it into the cave by means of wind as suggested by the much lower pollen counts collected from the trap inside the cave (Fig. S1). Interestingly, wind-pollinated types (e.g., *Quercus*, *Ulmus*, Chenopodiaceae and *Eriogonum*-type) tend to dominate over the insect-disseminated types (e.g., Papaveraceae, Convolvulaceae and some high-spine Asteraceae Tubuliflorae) in the cave entrance, but the opposite occurs for the trap inside the cave (Fig. S1). Although perhaps not a significant sample, these data suggest that a large number of pollen grains in the cave are coming in via animals and most recently humans as well. Throughout the record there is a considerable incidence of insect-disseminated types (examples named above), or types that do not often preserve well in an open environment (e.g., *Populus*, *Opuntia*, and *Juncus*, among others). Given the number and diversity of mammal species (See Toomey III, 1993), it is possible that the influx of pollen in the guts or skins of animals may be important, possibly adding to this is the introduction of species by birds and insects, and ultimately by humans.

However, wind and animals may not necessarily be the only way of pollen has been introduced to the interior of the cave, as sediment from outside may have carried some pollen grains through slopewash, which may have also contributed to the relatively high incidence of resistant pollen such as *Pinus* and *Picea*, and Ephedra, as well as fungal and a number of other resistant spores. One thing that is apparent in the modern pollen spectra (Fig. S1) is that, although absent in the pollen traps, *Pinus* is found in the pollen from the surface sample.

Phytoliths are most likely to be transported into the cave by slopewash processes, given that they tend to be abundant in soils. Wind may be also an important means of phytolith influx into the cave, as indicated by the one-year phytolith influx captured in the traps (Fig. S2). Nonetheless, data from the traps inside and outside the cave suggest that wind may be favoring small phytoliths, as short-cells tend to be abundant in comparison with sediment and soil samples (Fig. 6). The introduction of phytoliths into the cave by means of plant remains in animal guts is possible as well as those brought in inadvertently or deliberately by humans.

Spores are generally abundant, and many are clearly produced in the cave in that moisture inside is conducive to the growth of mosses and other spore-producing plants. Notably the two traps produced large quantities of spores, with the interior one containing the highest proportion. Fungal spores and *Sporormiella* in particular are abundant inside the cave due to the amount of dung being deposited by sheep.

Although the modes of transportation for pollen and phytoliths are important in the interpretation of their assemblages in the cave sediments, it is difficult in some cases to determine exactly their way. Presumably, their origin of most pollen is in the areas nearby regardless of their mode of transportation, with the exception of bisaccate pollen (*Pinus* and *Picea*) which tend to travel long distances (Bryant and Holloway, 1985; Hall and Valastro, 1995). In such case, it is possible to interpret these taxa as regional vegetation change.

Related to the influx of pollen and phytoliths into the cave, particularly by wind, is the opening of the cave entrance, which presumably grew wider during the 18,000 years of the record. The cone of debris and many of the clast layers embedded may not necessarily be related to, as assessed by Toomey III (1993). The increase in pollen and phytolith concentration (Figs. 4 and 8 in the article, respectively) began around 9 ka, however, the assemblage of spores in the record changes around this time (Fig. 7). Additionally, the concentration of charcoal and the presumed anthropogenically transported pollen such as *Opuntia* (see discussion below) may be an indicator that the cave entrance was open and more accessible to humans. Coincidentally, after this time is lithic material occurs in larger quantities (Toomey III, 1993). It is possible that the successive collapse of the roof at the entrance may have allowed more access to humans. Notably, debris attest for this, notably the one between 100 and 95 cm (Fig. 3), roughly 8-7 ka, suggest the possibility of substantial roof collapse.

*Archaeological record and human disturbance of the deposits*

Reports of lithics recovered by sediment sieving suggest the presence of humans in or immediately above the cave for the entire Holocene (Toomey III, 1993). However, whether the lithic artifacts have been deposited inside or brought in by runoff flowing into the cave is difficult to ascertain, especially given the cave is located near an archaeological site (Toomey III, 1993). However, evidence of disturbance by humans is apparent in the cave's stratigraphy, particularly with the presence of hearths in Unit 1 and in the upper part of the Unit 2 excavated elsewhere in the cave (Toomey III, 1993).

Although clearly visible in the stratigraphy, presence of humans appears to occur about 4 ka in the phytolith record, which shows an unusually high concentration of phytoliths, initially consisting primarily of ligneous-plants phytoliths and subsequently with an even more unusual proportion of grass phytoliths (Fig. 9). However, human influence may be as early as 8.5 ka given the uncharacteristically high concentrations of Umbelliferae (Fig. 6). Although this could be the result of disturbance around the cave, the contemporaneous high proportion of *Opuntia* pollen is likely indicative of human activity. *Opuntia*, like most Cactaceae, produce large pollen grains (55-70 μm) that are very prone to destruction, which is why Cactaceae family are typically absent in pollen records, even in areas where members of this family are abundant. In this instance, protection offered by the cave in combination with rapid sedimentation would have preserved the grains.

Human activity in caves has been determined to be an important influence on paleoecological records, given that humans introduce, intentionally or unintentionally, biological materials (Anderson 1955; Butzer, 1982; Camacho et al., 2000; Expósito et al., 2017). Even minor and short occupations of the cave could have affected the microfossil record, which could alter reconstructions of paleoclimate. Human influence has impacted paleoclimate modeling using the cave's phytolith record (Joines, 2011). Thus, modeling phytoliths using modern analog transfer function produced mean annual temperature curves that show that after 2ka years have been even colder than those before 16 ka, suggesting that such a reconstruction was affected by noises in the phytolith record by plants introduced in the cave by humans (Joines, 2011). In essence, though, this suggest that data from Hall's Cave sediments at least in the middle and late Holocene should be interpreted with care when used for paleoclimatic reconstruction.

*Interpretation of microscopic charcoal and Sporormiella*

The relative abundance of microscopic charcoal is customarily used in pollen analysis as a proxy for reconstructing fire incidence. Although most charcoals for paleofire reconstruction are recovered from lacustrine deposits, interpretable records have been developed from soils, alluvial deposits, and hyrax middens, among others (Carcaillet and Talon 2001; Cordova et al. 2011). However, charcoal from cave deposits could be a problem because of their concealment from the outside and the possibility of charcoal being produced by human fires inside the cave. In the case of Hall's Cave, human occupation would have increased the influx of charcoal, in fact the upper zones, 2b and 3, have enormous concentrations of charcoal, which may well be related to human occupation given the occurrence of hearths in the stratigraphy of the upper units (Fig. 3).

Palynological studies in North America often include also the coprophilous fungal *Sporormiella* for reconstructing herbivore densities (Davis and Shafer 2006; Gill et al. 2009; Feranec et al. 2011), despite many issues relating to rate of production of *Sporormiella* and relationship with herbivore density in varied environments (cf. Gill et al. 2013; Wood et al. 2012). Nonetheless, one may assume that *Sporormiella* spores originated in the catchment that provides sediments to the cave by sheetwash and that charcoal entered the cave's stratigraphic record via sheetwash and wind entering the orifice of the cave. Like in the case of charcoal, high levels of *Sporormiella* in the same profile may be related to humans, particularly due to the common practice of Native American groups of using bison dung chips for fuel.

However, it is possible to exclude the part of the stratigraphic sequence with evidence of human evidence. Thus, based on the reports of artifact findings by Toomey III (1993) and the incidence of *Opuntia* and Umbelliferae pollen (Fig. 6), it is possible that human presence begins sometime around 8 ka, during which some parts contain large concentrations of charcoal and *Sporormiella* (Fig. 4) possibly due to the use of the cave by humans.

Thus, a diagram encompassing the time prior to 8 ka permits appreciating better the incidence of *Sporormiella* and charcoal (Fig. S5). *Sporormiella* concentrations are relatively high, peaking between 15 and 13.5 ka, declining considerably, almost disappearing from the record, afterwards. One moderate peak occurs around 11.5 ka and a small peak around 9.3 ka. Charcoal concentration, on the other hand, display an opposite trend to *Sporormiella* concentrations, as the highest incidence of charcoal is low before 13.5 ka. In fact, the lowest charcoal incidence occurs at the time when *Sporormiella* concentrations are high between 15 and 13.5 ka. Afterwards, the peaks of charcoal concentrations become considerably high.

The explanation for the opposite trends between charcoal and *Sporormiella* concentration may lie in the general trend of these two proxies in other parts of the continent, which has been interpreted as the reduction of large herbivores (i.e., producers of large amounts of dung) may have led to the low incidence of *Sporormiella* in sediments (Davis and Shafer 2006; Gill et al, 2009). Accordingly, the decrease of large herbivores, presumably because of the extinctions (ca. 13 ka) had an impact on the increase of biomass for fire fuel, resulting in higher incidence of charcoal (Gill et al., 2009). . Such trends, however, have been studied in pollen records in lake and marsh sediments, which are sedimentary environments different from the one in Hall's Cave. Nonetheless, the nature of Hall's Cave as a sediment trap from its small catchment (Fig. 2), may constitute a record for local trends in environmental changes that could represent trends at larger scale.

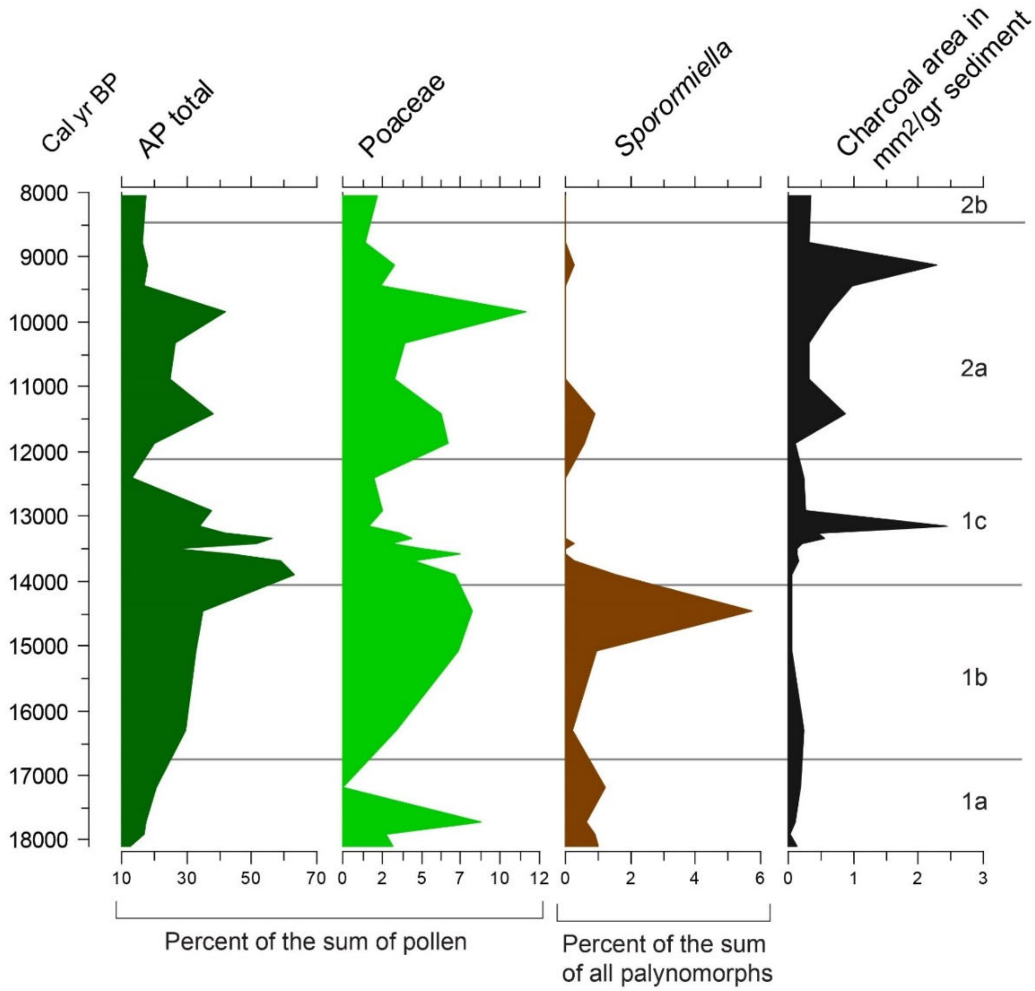


Fig. S5. Distribution of the *Sporormiella* and charcoal record relative to AP and Poaceae pollen prior to 8 ka.

It is also noticeable that the increases in *Sporormiella* coincide with high frequencies of Poaceae (Fig. S5), suggesting that conditions for grazing may have been optimal for herbivores in the area. Conversely, the peaks of charcoal coincide with peaks in arboreal pollen (Fig. S5), perhaps suggesting that flammability may be associated with the availability of wood. Nonetheless, other factors need to be considered for fire, particularly the change to higher insolation and higher seasonality (cf. Power et al. 2008), and perhaps with the incidence of humans as modifiers of vegetation by fire (Cordova et al. 2011).

**7. References**

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Toomey III, R.S., 1993. Late Pleistocene and Holocene faunal and environmental changes at Hall's Cave, Kerr County, Texas. PhD dissertation, University of Texas at Austin.

Wood, J.R. and Wilmshurst, J.M., 2012. Wetland soil moisture complicates the use of Sporormiella to trace past herbivore populations. Journal of Quaternary Science 27, 254-259.

**8. Appendix. Data sets**

Table S1 Modern pollen counts

Table S2 Modern phytolith counts

Table S3 Radiocarbon dates (Cooke et al. 2003)

Table S4 Bacon age model results

Table S5 Sedimentation rates

Table S6 Pollen, spore and other palynomorph counts

Table S7 Charcoal concentration

Table S8 PCA eigenvalues, percent variance, and loadings for PC1 and PC2 axes

Table S9 Phytolith counts

Table S10 Diagnostic grass silica short cells (GSSC) and ratios.

## Table S1 Modern pollen counts

| Sample >>>>>>>>>> | Entrance trap | Inside Trap | Mod. Surface |
|---|---|---|---|
| List of taxa | Counts | Counts | Counts |
| Pinus | | | 8 |
| Picea | | | |
| Abies | | | |
| Cuppressaceae | 17 | 13 | 8 |
| Taxodium | | | |
| Salix | | | |
| Populus | | | 2 |
| Juglans | | | 2 |
| Carya | | 1 | 2 |
| Alnus | | | |
| Betula | | | |
| Corylus | | | |
| Ostrya-Carpinus | | | |
| Fagus | | | |
| Quercus | 242 | 9 | 168 |
| Ulmus | 5 | | |
| Celtis | 1 | 1 | 4 |
| Moraceae | 1 | | 2 |
| Loranthaceae | | | |
| Vitis | | | |
| Tilia | | | |
| Pyrus type | | | 1 |
| Liquidambar | | | |
| Mimosa-Acacia | | | |
| Tamarix | | | |

| | | | |
|---|---|---|---|
| Robinia | | | |
| Prosopis-type | | | |
| Pistacia | | | |
| Rhus | | 1 | |
| Acer | | | |
| Rhamnaceae | | 1 | |
| Cornus | | | 1 |
| Ericaceae | | | |
| Fraxinus | | | 2 |
| Sambucus | | | |
| Other AP | | | |
| AP total | 266 | 26 | |
| Ephedra | | | |
| Urtica type | | | |
| Chenopodiaceae | 1 | | 3 |
| Caryophyllaceae | | | |
| Opuntia | | | |
| Eriogonum type | 1 | | |
| Polygonum amphibius type | | | |
| Rumex type | | | |
| Polygonaceae total | | | |
| Ranunculaceae | | | |
| Saxifragaceae/Ribes | | | |
| Berberidaceae | | | |
| Papaveraceae | | 1 | |
| Cruciferae | | | 2 |
| Rosaceae | | | |
| Trifolium type | 2 | | |
| Medicago | | | |
| Other Fabs | 1 | 1 | 2 |
| Oxalis | | | |
| Erodium | | | |
| Geraniaceae | | | |
| Linum type | | 1 | |
| Euphorbiaceae | | | |
| Malvaceae | | | |
| Hedera | | | |
| Umbelliferae | | | 1 |
| Plumbaginaceae | | | |
| Onagraceae | | | 1 |
| Solanaceae | | | 1 |
| Convolvulaceae | | | 1 |
| Boraginaceae | | | |
| Salvia type | | | |

| | | | |
|---|---|---|---|
| Pedicularis type | | | |
| Verbascum type | | | |
| Plantago | 1 | 1 | |
| Rubiaceae | | | |
| Valerianaceae | | | |
| Campanula type | | | |
| Artemisia | | | 2 |
| Centaurea type | 1 | | |
| Serratula type | | | |
| Ambrosia-type | 1 | 2 | 7 |
| Aster type | 1 | 6 | 9 |
| Cirsium type | | 1 | |
| Asteraceae liguliflorae | | 1 | 1 |
| Other herbs | 2 | 2 | 12 |
| Poaceae | 2 | 3 | 4 |
| Liliaceae | | | |
| Cyperaceae | 1 | | |
| NAP total | 14 | 19 | |
| Typhaceae | | | |
| Sparganiaceae | | | |
| Juncaceae | | | |
| Iridaceae | | | |
| Potamogeton | | | |
| Aquatics other | | | |
| Aquatics total | | | |
| Unidentified pollen | 1 | 2 | |
| TOTAL POLLEN without deterioration | 281 | 47 | 246 |
| | | | |
| Corroded | 4 | | 20 |
| Broken | 1 | | 3 |
| Pitted | | | |
| Crumpled | 2 | 3 | 9 |
| Deterioration total | | | |
| | | | |
| Bryophytes | | 1 | 5 |
| Polypodaceae | | | 1 |
| Cryptogam | | | |
| Botrychium | | | |
| Other spores | 31 | 32 | 39 |
| Cladosporium | | 1 | 15 |
| Mycorrhizae | | | 10 |
| Pseudoschizera | | | 2 |
| Non-identified fungal spores | 12 | 51 | 150 |
| Sporormiella | 8 | 58 | 310 |

| | | | |
|---|---|---|---|
| Total spores | 51 | 143 | 532 |
| Total palynomorphs | 339 | 193 | 810 |
| Total area charcoal counted | | | 10164 |

## Table S2 Modern phytolith counts

| | Entrance trap | Inside trap | Soil outside | Surface inside |
|---|---|---|---|---|
| Morphotype: | | | | |
| Keeled | 2 | | 1 | 4 |
| Conical | 2 | 2 | 4 | 3 |
| Pyramidal | | | 1 | 2 |
| Round and trapezoidal | 1 | 1 | 0 | 1 |
| Long wavy trapezoid | | 2 | 2 | 1 |
| Stipa-type | 8 | 7 | 4 | 3 |
| Long straight trapezoidal | | | 1 | 1 |
| Panicoid bilobates | 15 | 10 | 9 | 22 |
| Polylobates | 1 | | 0 | 0 |
| Crosses | 3 | | 2 | 11 |
| Two-side horned panicoid | 3 | | 1 | 1 |
| Short saddles | 16 | 7 | 26 | 40 |
| Ellipsoid saddles (Spartina-type) | 2 | | 0 | 1 |
| Aristida-type bilobates | 6 | 8 | 3 | 5 |
| Plateau saddles (Phragmites-type) | | 1 | 0 | 0 |
| Long saddles | | 1 | 0 | 0 |
| Bamb and oryz types | | | 0 | 0 |
| Other bilobates | 3 | 9 | 13 | 19 |
| Flat towers | | | 1 | 1 |
| Horned towers and spools | 1 | | 1 | 8 |
| Other non-diagnostic | 10 | 7 | 46 | 48 |
| Smooth | 4 | 2 | 3 | 21 |
| Sinuous | | | 0 | 6 |
| Serrated | | | 4 | 2 |
| Echinate | | | 2 | 1 |
| Dendritic | | | 0 | 0 |
| Long point | 5 | 2 | 7 | 2 |
| Short pointy | 1 | 1 | 2 | 10 |
| Fan-bamboo | | | 0 | 0 |
| Fan-reed | | | 0 | 0 |
| Fan | | | 8 | 4 |
| Square | 4 | 3 | 18 | 6 |
| Rectangular | 6 | | 17 | 3 |

| | | | | |
|---|---|---|---|---|
| Broad elongate | 1 | 1 | 9 | 5 |
| Undetermined | 3 | 6 | 24 | 12 |
| Cyperaceae | | | 0 | |
| Cyperaceae-type papillae | | | 0 | 0 |
| Asteraceae platelets | | | 0 | 0 |
| Celtis type | 1 | 1 | 0 | 3 |
| Blocky | 4 | 4 | 141 | 48 |
| Scalloped faceted | 1 | | 1 | 1 |
| Globular | 1 | 2 | | |
| Maclura type blocky hairbase | | | | |
| Gobbet - irregular | 10 | 6 | 0 | 0 |
| Other | 1 | 2 | 7 | 0 |
| TOTAL NON-GRAMINOID | 18 | 15 | 149 | 52 |
| Total GRAMINOID | 97 | 70 | 209 | 243 |

## Table S3 Radiocarbon dates (Cooke et al. 2003)

| TMM Cat. number | Depth | Material dated | RC age (+/-1σ) |
|---|---|---|---|
| 41229-12115 | 15-20 | gelatin | 1500 +/- 60 |
| 41229-12118 | 25-30 | gelatin | 2330 +/- 60 |
| 41229-12083 | 51 | charcoal | 3190 +/- 70 |
| 41229-12117 | 60-65 | gelatin | 4000 +/- 60 |
| 41229-12099 | 76-78 | humins | 5400 +/- 70 |
| 41229-12162 | 90-95 | gelatin | 5320 +/- 60 |
| 41229-12164 | 105-110 | gelatin | 7700 +/- 80 |
| 41229-12166 | 120-125 | gelatin | 8630 +/- 60 |
| 41229-12080 | 145-150 | gelatin | 10310 +/- 70 |
| 41229-12075 | 155-160 | liquified gelatin | 11310 +/- 60 |
| 41229-12173 | 165-170 | gelatin | 11410 +/- 70 |
| 41229-N.D. | 185-190 | gelatin | 11550 +/- 70 |
| 41229-12176 | 195-200 | gelatin | 12110 +/- 90 |
| 41229-12177 | 210-215 | liquified gelatin | 14400 +/- 80 |

| | | | |
|---|---|---|---|
| 41229-12073 | 220-225 | gelatin | 12570 +/- 80 |
| 41229-12076 | 235-240 | gelatin | 14700 +/- 90 |
| 41229-12137 | 260 | humic acid | 15290 +/- 90 |
| 41229-12179 | 270-275 | gelatin | 13940 +/- 100 |
| 41229-12180 | 295-300 | gelatin | 16240 +/- 100 |
| 41229-12181 | 300-305 | gelatin | 16620 +/- 110 |
| 41229-12183 | 315-320 | gelatin | 16510 +/- 100 |
| 41229-12131 | 338-343 | humic acid | 16610 +/- 110 |
| 41229-12184 | 345-350 | gelatin | 16770 +/- 100 |

## Table S4 Bacon age model results

Bacon model

| depth | min | max | median | wmean |
|---|---|---|---|---|
| 0 | -8 | 104.9 | -7.3 | 1.6 |
| 1 | -1.3 | 191.6 | 65.5 | 72.6 |
| 2 | 3.9 | 363 | 135.5 | 146.8 |
| 3 | 9.3 | 534.8 | 204.8 | 220.7 |
| 4 | 14 | 707.9 | 272.6 | 294 |
| 5 | 18.7 | 874.4 | 341.1 | 367.5 |
| 6 | 85.9 | 921.4 | 436.7 | 456.5 |
| 7 | 122.7 | 975.2 | 541.1 | 546.6 |
| 8 | 155.3 | 1042.1 | 652.5 | 636 |
| 9 | 185.2 | 1154.2 | 760.1 | 725.8 |
| 10 | 216.8 | 1296.3 | 847.4 | 815.4 |
| 11 | 394.5 | 1316.3 | 912.4 | 890.5 |
| 12 | 550.7 | 1345.5 | 977.7 | 966.5 |
| 13 | 652.8 | 1374.8 | 1049 | 1042.8 |
| 14 | 738.7 | 1418 | 1129.7 | 1119.2 |
| 15 | 811.5 | 1498.1 | 1209.4 | 1195.2 |
| 16 | 1016.2 | 1518.9 | 1289 | 1284.9 |
| 17 | 1198.3 | 1554.7 | 1363.8 | 1373.5 |
| 18 | 1310.2 | 1638.3 | 1453.7 | 1463.4 |
| 19 | 1345.5 | 1795.3 | 1546.2 | 1554 |
| 20 | 1369.7 | 1987.8 | 1627 | 1644.6 |
| 21 | 1487.7 | 2037.7 | 1721.5 | 1736.9 |
| 22 | 1578.2 | 2103.7 | 1820.1 | 1830.1 |

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| 23 | 1645.3 | 2189.7 | 1919.1 | 1923.7 |
| 24 | 1698 | 2306.2 | 2014.3 | 2016.9 |
| 25 | 1740.3 | 2451.9 | 2108.5 | 2109.5 |
| 26 | 1894.6 | 2490.3 | 2172.9 | 2183.7 |
| 27 | 2019.1 | 2548.5 | 2250.1 | 2258.1 |
| 28 | 2086.8 | 2621.2 | 2336.5 | 2332.1 |
| 29 | 2138.6 | 2721.9 | 2400.4 | 2405.3 |
| 30 | 2174.1 | 2853.5 | 2460.7 | 2478.8 |
| 31 | 2214.8 | 2878.4 | 2501.9 | 2519.2 |
| 32 | 2242 | 2917.4 | 2547.7 | 2559.7 |
| 33 | 2266.3 | 2969.7 | 2590.1 | 2600.6 |
| 34 | 2287.7 | 3031.4 | 2629.9 | 2641.6 |
| 35 | 2305.2 | 3107.8 | 2669.1 | 2682.5 |
| 36 | 2370 | 3132.7 | 2715.7 | 2728.3 |
| 37 | 2413.6 | 3160.2 | 2764.3 | 2774 |
| 38 | 2444 | 3202.1 | 2812.2 | 2820.1 |
| 39 | 2472.8 | 3251.4 | 2860 | 2866.2 |
| 40 | 2495.4 | 3316.7 | 2907.3 | 2912.4 |
| 41 | 2558.6 | 3341.2 | 2950.1 | 2954.6 |
| 42 | 2611.7 | 3364.3 | 2995.6 | 2997.4 |
| 43 | 2648.3 | 3400.3 | 3040 | 3040.3 |
| 44 | 2682.3 | 3437.6 | 3085.1 | 3083.4 |
| 45 | 2712.3 | 3491.4 | 3128.7 | 3126.3 |
| 46 | 2812.3 | 3511.5 | 3169.9 | 3173.8 |
| 47 | 2907.3 | 3536.1 | 3213.7 | 3221.2 |
| 48 | 2986.2 | 3571.1 | 3260.3 | 3269 |
| 49 | 3045.2 | 3618.7 | 3309.8 | 3316.9 |
| 50 | 3088.3 | 3675.8 | 3359.1 | 3364 |
| 51 | 3213 | 3727.5 | 3436.3 | 3449.4 |
| 52 | 3292.5 | 3803.3 | 3525.7 | 3534.7 |
| 53 | 3333.6 | 3922.4 | 3610.7 | 3620.1 |
| 54 | 3367.8 | 4088.9 | 3685.8 | 3705.5 |
| 55 | 3394 | 4280.2 | 3758.9 | 3791.4 |
| 56 | 3505.9 | 4321 | 3844.3 | 3873.1 |
| 57 | 3576.6 | 4366.3 | 3939.8 | 3955.4 |
| 58 | 3629.1 | 4426.4 | 4040.1 | 4037.9 |
| 59 | 3668.4 | 4514 | 4134 | 4120.4 |
| 60 | 3703.8 | 4628.6 | 4218.1 | 4202.1 |
| 61 | 3938.5 | 4674.3 | 4313.9 | 4309.7 |
| 62 | 4144.5 | 4737.5 | 4413.6 | 4419.2 |
| 63 | 4262.5 | 4831.9 | 4518.5 | 4528.6 |
| 64 | 4330.6 | 4981.4 | 4622 | 4637.1 |
| 65 | 4374.9 | 5196.4 | 4719.3 | 4745.4 |
| 66 | 4482.3 | 5264.7 | 4847.4 | 4861.3 |

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| 68 | 4586.3 | 5526 | 5111 | 5095.8 |
| 69 | 4623.1 | 5720.5 | 5225.7 | 5212.2 |
| 70 | 4656.1 | 5948.1 | 5334.4 | 5327.7 |
| 71 | 4799.7 | 5966.4 | 5428.6 | 5422.4 |
| 72 | 4923.6 | 5990.7 | 5525.7 | 5518.7 |
| 73 | 5011.4 | 6025.1 | 5629.9 | 5615.5 |
| 74 | 5072.6 | 6077 | 5747.5 | 5712 |
| 75 | 5126.5 | 6167.7 | 5862.2 | 5808 |
| 76 | 5174.1 | 6190.3 | 5911.2 | 5849.7 |
| 77 | 5206 | 6228.2 | 5956 | 5890.2 |
| 78 | 5241 | 6309.1 | 5989.2 | 5931.8 |
| 79 | 5280.5 | 6413.9 | 6013.7 | 5972 |
| 80 | 5312.7 | 6552.7 | 6036.8 | 6011.5 |
| 81 | 5375.6 | 6581.9 | 6051.6 | 6035 |
| 82 | 5436.3 | 6619.6 | 6065.3 | 6058.1 |
| 83 | 5506.8 | 6662 | 6079.4 | 6081.2 |
| 84 | 5557 | 6710.3 | 6094.7 | 6104.5 |
| 85 | 5604.6 | 6767.4 | 6110.6 | 6127.4 |
| 86 | 5665.3 | 6799.9 | 6126.1 | 6151.2 |
| 87 | 5726.3 | 6853.8 | 6141.6 | 6175 |
| 88 | 5781.8 | 6905.6 | 6156.8 | 6198.6 |
| 89 | 5820.8 | 6954.8 | 6172.7 | 6221.8 |
| 90 | 5856.4 | 7015.7 | 6191.3 | 6245.7 |
| 91 | 5933.3 | 7071 | 6215 | 6282.4 |
| 92 | 5997.9 | 7130.9 | 6241.1 | 6319.2 |
| 93 | 6044.9 | 7195.1 | 6270.3 | 6358 |
| 94 | 6081.8 | 7280.5 | 6301.9 | 6396.9 |
| 95 | 6106.8 | 7373 | 6335.5 | 6436.4 |
| 96 | 6221.8 | 7480.8 | 6505.1 | 6587.5 |
| 97 | 6276.2 | 7603.7 | 6684.5 | 6739.7 |
| 98 | 6314 | 7736.3 | 6853.2 | 6892.3 |
| 99 | 6343.1 | 7908.3 | 7014.4 | 7045.3 |
| 100 | 6366.4 | 8157.6 | 7171.1 | 7197.7 |
| 101 | 6650.4 | 8196 | 7331.7 | 7366.9 |
| 102 | 6875.8 | 8248.7 | 7505.1 | 7538.7 |
| 103 | 7028.4 | 8320.6 | 7701 | 7710.5 |
| 104 | 7133.1 | 8418.9 | 7905.7 | 7882.3 |
| 105 | 7211.4 | 8576 | 8105.6 | 8052.6 |
| 106 | 7590.7 | 8610.2 | 8229.4 | 8198.2 |
| 107 | 7944.4 | 8656.6 | 8359.7 | 8344.5 |
| 108 | 8218.7 | 8740.7 | 8492.4 | 8494 |
| 109 | 8357 | 8923.5 | 8635.3 | 8641.2 |
| 110 | 8444.8 | 9255.4 | 8755.4 | 8786.5 |

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| 111 | 8512.9 | 9295.2 | 8828.5 | 8852.1 |
| 112 | 8561.5 | 9343.6 | 8905.5 | 8919.3 |
| 113 | 8602.2 | 9404.7 | 8978.3 | 8986.6 |
| 114 | 8632.9 | 9504.2 | 9044.4 | 9053.6 |
| 115 | 8656.7 | 9622.1 | 9106.1 | 9119.9 |
| 116 | 8754 | 9653.8 | 9173.3 | 9184.1 |
| 117 | 8823.3 | 9688.1 | 9243.1 | 9249.9 |
| 118 | 8879 | 9741.3 | 9317.6 | 9315.3 |
| 119 | 8926.8 | 9811.1 | 9390.1 | 9380.6 |
| 120 | 8969.1 | 9893.7 | 9460.7 | 9446 |
| 121 | 9166 | 9934 | 9527.3 | 9527.5 |
| 122 | 9358.4 | 9993 | 9592.9 | 9610.2 |
| 123 | 9514.8 | 10085.2 | 9662 | 9693.5 |
| 124 | 9583 | 10178.8 | 9741 | 9775.2 |
| 125 | 9612.7 | 10279.4 | 9819.7 | 9855.6 |
| 126 | 9670 | 10371.4 | 9920.3 | 9947.8 |
| 127 | 9705.7 | 10495.7 | 10011.6 | 10039.3 |
| 128 | 9727.6 | 10678.8 | 10098.9 | 10131.3 |
| 129 | 9746 | 10890.4 | 10180.2 | 10222 |
| 130 | 9764.2 | 11109.5 | 10259.1 | 10312.5 |
| 131 | 9861 | 11187.8 | 10384.2 | 10426.5 |
| 132 | 9921.3 | 11273.8 | 10513.3 | 10540.4 |
| 133 | 9965.2 | 11392.9 | 10631.9 | 10654.6 |
| 134 | 10003.2 | 11562.5 | 10745.5 | 10767.7 |
| 135 | 10033.8 | 11775.2 | 10854.8 | 10880.1 |
| 136 | 10202.6 | 11814.6 | 10961.2 | 10984.9 |
| 137 | 10313.5 | 11863 | 11080.6 | 11091.2 |
| 138 | 10391.2 | 11918.9 | 11202.9 | 11197.2 |
| 139 | 10465 | 12008.4 | 11319.5 | 11303.3 |
| 140 | 10520.7 | 12148.5 | 11425.5 | 11409.1 |
| 141 | 10714.9 | 12178.1 | 11508.6 | 11501.9 |
| 142 | 10878.5 | 12214.3 | 11601.2 | 11594.4 |
| 143 | 10986.1 | 12257.2 | 11702 | 11687.6 |
| 144 | 11065.5 | 12311.6 | 11803.5 | 11780.4 |
| 145 | 11132.5 | 12389.4 | 11902.7 | 11873.7 |
| 146 | 11386.8 | 12420.4 | 11994 | 11977.3 |
| 147 | 11631.5 | 12461.1 | 12084.2 | 12082.1 |
| 148 | 11805.9 | 12539.1 | 12185.1 | 12188.9 |
| 149 | 11915.3 | 12638.4 | 12292.6 | 12296.8 |
| 150 | 11972.3 | 12802.7 | 12399.3 | 12402.6 |
| 151 | 12124.5 | 12858 | 12500.7 | 12502.5 |
| 152 | 12242.6 | 12911.5 | 12606.7 | 12601.6 |
| 153 | 12322.6 | 12982.5 | 12717.8 | 12701.2 |
| 154 | 12379.6 | 13080.5 | 12826.7 | 12801.9 |

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| 155 | 12427.9 | 13219.2 | 12930.2 | 12901.3 |
| 156 | 12553.7 | 13228.4 | 12982.5 | 12951.6 |
| 157 | 12667.4 | 13242 | 13037.1 | 13001.7 |
| 158 | 12760.2 | 13261.8 | 13091 | 13053.6 |
| 159 | 12830.4 | 13295.5 | 13143 | 13105.4 |
| 160 | 12867.1 | 13351.9 | 13187.4 | 13155.7 |
| 161 | 12911.2 | 13363.8 | 13200.9 | 13175 |
| 162 | 12946.4 | 13377.9 | 13215.9 | 13194.8 |
| 163 | 12974.3 | 13393.9 | 13230.8 | 13214.7 |
| 164 | 12999.4 | 13413.2 | 13247.2 | 13234.7 |
| 165 | 13021.4 | 13434.5 | 13264.3 | 13254.8 |
| 166 | 13067.5 | 13446.4 | 13279.5 | 13273.7 |
| 167 | 13109.5 | 13461.7 | 13295.2 | 13292.6 |
| 168 | 13144.8 | 13478.5 | 13311.9 | 13311.4 |
| 169 | 13170.4 | 13498.3 | 13329.1 | 13330.1 |
| 170 | 13187 | 13523.3 | 13345.2 | 13348.2 |
| 171 | 13207 | 13545.1 | 13361.3 | 13364.4 |
| 172 | 13218.9 | 13567.6 | 13377.3 | 13380.8 |
| 173 | 13228.6 | 13591.2 | 13390.4 | 13395 |
| 174 | 13233.6 | 13621.6 | 13402.1 | 13409.7 |
| 175 | 13237.6 | 13654.4 | 13413.5 | 13424 |
| 176 | 13255.3 | 13667.3 | 13428.8 | 13439.9 |
| 177 | 13267.1 | 13686.6 | 13443.7 | 13456 |
| 178 | 13279.8 | 13711.3 | 13458.1 | 13471.2 |
| 179 | 13288 | 13739.1 | 13471.9 | 13487.2 |
| 180 | 13296.9 | 13764 | 13485.2 | 13502.8 |
| 181 | 13318 | 13784.4 | 13502.3 | 13520 |
| 182 | 13335.9 | 13804.9 | 13518.6 | 13536.6 |
| 183 | 13350.8 | 13827.7 | 13535.3 | 13553.6 |
| 184 | 13359.8 | 13856.6 | 13551.8 | 13570.4 |
| 185 | 13368.9 | 13883.8 | 13567.3 | 13587.1 |
| 186 | 13395.4 | 13904.4 | 13586 | 13606.8 |
| 187 | 13419.2 | 13921 | 13603.8 | 13626.1 |
| 188 | 13438.2 | 13954.4 | 13622.3 | 13645.8 |
| 189 | 13451.5 | 13980.8 | 13641.3 | 13665.5 |
| 190 | 13463.8 | 14006 | 13659.6 | 13685.4 |
| 191 | 13513.6 | 14039 | 13706.3 | 13730.3 |
| 192 | 13544.3 | 14086.4 | 13755.6 | 13775.5 |
| 193 | 13567.5 | 14152.4 | 13806.5 | 13820.4 |
| 194 | 13586.6 | 14227.8 | 13853.8 | 13865.1 |
| 195 | 13605 | 14302.6 | 13896.1 | 13909.8 |
| 196 | 13686.2 | 14337.9 | 13939.2 | 13957 |
| 197 | 13752.1 | 14389.7 | 13986 | 14004.4 |
| 198 | 13806.1 | 14443.6 | 14034.2 | 14052.1 |

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| 199 | 13844.3 | 14505.9 | 14082.2 | 14099.5 |
| 200 | 13869.4 | 14589.8 | 14127.2 | 14147.1 |
| 201 | 13913.1 | 14678.8 | 14183.2 | 14209.5 |
| 202 | 13944.3 | 14859.1 | 14234.2 | 14271.6 |
| 203 | 13961.7 | 15017.8 | 14284.1 | 14333 |
| 204 | 13974.1 | 15203.9 | 14328.5 | 14393.2 |
| 205 | 13979.9 | 15387.1 | 14373.6 | 14453.8 |
| 206 | 14027.3 | 15517.6 | 14434 | 14522.3 |
| 207 | 14066.6 | 15727.4 | 14492 | 14591.8 |
| 208 | 14095.6 | 16002.9 | 14549 | 14661.7 |
| 209 | 14120.2 | 16312.5 | 14604.5 | 14730.3 |
| 210 | 14140.6 | 16525.8 | 14657.5 | 14799.1 |
| 211 | 14196.7 | 16586.2 | 14706.1 | 14851.8 |
| 212 | 14239.4 | 16662 | 14757 | 14906.3 |
| 213 | 14279.2 | 16716.7 | 14807.2 | 14960.3 |
| 214 | 14308.4 | 16796.7 | 14858.7 | 15014.5 |
| 215 | 14335.2 | 16867.7 | 14907.1 | 15068.6 |
| 216 | 14400 | 16917.1 | 14940.1 | 15109.2 |
| 217 | 14453.4 | 16942.2 | 14972.9 | 15150.6 |
| 218 | 14493.1 | 17018.2 | 15007.7 | 15192.1 |
| 219 | 14531.6 | 17054.5 | 15046.4 | 15233.7 |
| 220 | 14563.8 | 17112 | 15085.9 | 15274.1 |
| 221 | 14656.7 | 17128.3 | 15122.5 | 15321.3 |
| 222 | 14739.3 | 17156.7 | 15162.5 | 15368.8 |
| 223 | 14807.7 | 17189.4 | 15201.4 | 15416.8 |
| 224 | 14851.9 | 17227.3 | 15245.1 | 15464 |
| 225 | 14886.7 | 17257.5 | 15297.8 | 15513 |
| 226 | 15037.9 | 17332.1 | 15493.9 | 15672.5 |
| 227 | 15115.3 | 17392.8 | 15705.6 | 15833.7 |
| 228 | 15183.9 | 17468.9 | 15906.1 | 15995 |
| 229 | 15237.7 | 17538.7 | 16088.1 | 16155.2 |
| 230 | 15280.5 | 17654.2 | 16264.4 | 16316 |
| 231 | 15478.8 | 17675 | 16450.9 | 16483.8 |
| 232 | 15624.9 | 17713.9 | 16647.3 | 16656.1 |
| 233 | 15734.2 | 17762.2 | 16862.6 | 16829 |
| 234 | 15806 | 17821.1 | 17071.4 | 17000.8 |
| 235 | 15879.4 | 17950.1 | 17270.5 | 17173.9 |
| 236 | 16080.6 | 17970 | 17379.1 | 17281.2 |
| 237 | 16252.3 | 17998.4 | 17486.6 | 17389.8 |
| 238 | 16400.8 | 18033.4 | 17604.3 | 17499.1 |
| 239 | 16513.7 | 18087.8 | 17722.6 | 17609.3 |
| 240 | 16628.8 | 18196.7 | 17823.9 | 17717.6 |
| 241 | 16693.4 | 18220.2 | 17858.1 | 17755.1 |
| 242 | 16743.2 | 18251.3 | 17892.6 | 17793.7 |

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| 243 | 16798.9 | 18289.6 | 17924.3 | 17832.3 |
| 244 | 16850.9 | 18332.3 | 17956.1 | 17870.4 |
| 245 | 16890.6 | 18384.4 | 17985.8 | 17907.9 |
| 246 | 16965.6 | 18406.1 | 18020.8 | 17945.9 |
| 247 | 17034.7 | 18428.2 | 18054.1 | 17982.2 |
| 248 | 17083.5 | 18453.9 | 18087.8 | 18019.4 |
| 249 | 17139 | 18492.1 | 18121.2 | 18057.1 |
| 250 | 17170.6 | 18536.7 | 18151.6 | 18093.6 |
| 251 | 17230.9 | 18555 | 18187.6 | 18129.9 |
| 252 | 17278.3 | 18575.1 | 18222.5 | 18166.6 |
| 253 | 17351.6 | 18600.9 | 18259.7 | 18203.7 |
| 254 | 17419.3 | 18629.1 | 18295.2 | 18240.5 |
| 255 | 17458.5 | 18672.9 | 18328 | 18276.8 |
| 256 | 17530.8 | 18689.1 | 18364 | 18313.5 |
| 257 | 17589.8 | 18707.9 | 18401.7 | 18350.7 |
| 258 | 17649.1 | 18728.6 | 18437.7 | 18387.1 |
| 259 | 17692.8 | 18757.8 | 18473.2 | 18423.3 |
| 260 | 17736.5 | 18798.6 | 18510.2 | 18459.9 |
| 261 | 17768.7 | 18821.6 | 18536.1 | 18486.1 |
| 262 | 17805.3 | 18843.8 | 18561.2 | 18512.5 |
| 263 | 17837.4 | 18874 | 18588.1 | 18539.7 |
| 264 | 17861 | 18907.8 | 18611.8 | 18566.4 |
| 265 | 17882.2 | 18953.2 | 18635.1 | 18593.1 |
| 266 | 17916.2 | 18974.6 | 18656.1 | 18615.7 |
| 267 | 17936.1 | 18999.4 | 18676.8 | 18638.2 |
| 268 | 17952.9 | 19027.1 | 18696.8 | 18661.1 |
| 269 | 17965.3 | 19061.1 | 18716.9 | 18684.3 |
| 270 | 17980.4 | 19108.5 | 18736.6 | 18707.6 |
| 271 | 18009.6 | 19128.9 | 18757.1 | 18730.2 |
| 272 | 18023.9 | 19151.6 | 18779.2 | 18753.9 |
| 273 | 18047.4 | 19175.6 | 18800.2 | 18776.9 |
| 274 | 18072.2 | 19203.5 | 18822.3 | 18800 |
| 275 | 18097.3 | 19238.3 | 18844 | 18823.2 |
| 276 | 18161.6 | 19263.2 | 18876.7 | 18857.1 |
| 277 | 18220.5 | 19290.4 | 18911.8 | 18891.9 |
| 278 | 18280.7 | 19326.1 | 18944.9 | 18925.9 |
| 279 | 18338.3 | 19371.7 | 18978.5 | 18961 |
| 280 | 18374.6 | 19421.4 | 19010.5 | 18995.3 |
| 281 | 18426.7 | 19439 | 19044.5 | 19029.5 |
| 282 | 18478.9 | 19460.8 | 19078.7 | 19063.4 |
| 283 | 18513 | 19489.7 | 19112.4 | 19097.4 |
| 284 | 18564.1 | 19530.4 | 19146.2 | 19132 |
| 285 | 18600.5 | 19575.3 | 19179.5 | 19166.7 |
| 286 | 18667.7 | 19593 | 19213.8 | 19201.2 |

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| 287 | 18741.4 | 19611.4 | 19248.5 | 19236.6 |
| 288 | 18791.2 | 19633.8 | 19284.6 | 19272 |
| 289 | 18821.4 | 19665.7 | 19320 | 19306.9 |
| 290 | 18853.1 | 19704.5 | 19355.6 | 19342.5 |
| 291 | 18924.8 | 19719.4 | 19389.2 | 19377.4 |
| 292 | 18981.4 | 19735.6 | 19425.1 | 19412.9 |
| 293 | 19044.4 | 19755.9 | 19460.5 | 19448.4 |
| 294 | 19082.9 | 19781 | 19499 | 19484.6 |
| 295 | 19117.9 | 19819 | 19533.6 | 19520.4 |
| 296 | 19202.4 | 19836.1 | 19565.3 | 19554.4 |
| 297 | 19269.2 | 19851.2 | 19597.4 | 19589.1 |
| 298 | 19329.5 | 19868.5 | 19630.5 | 19623.8 |
| 299 | 19375.9 | 19892.8 | 19665.3 | 19659 |
| 300 | 19412.8 | 19929.1 | 19701.2 | 19694.5 |
| 301 | 19454.6 | 19943.2 | 19724.5 | 19720 |
| 302 | 19487.3 | 19965.6 | 19747 | 19745.4 |
| 303 | 19514.1 | 19988.3 | 19770.7 | 19770.8 |
| 304 | 19536.2 | 20017.9 | 19792.5 | 19796.1 |
| 305 | 19557.4 | 20057.6 | 19816 | 19821 |
| 306 | 19578.6 | 20071.1 | 19831.4 | 19836.9 |
| 307 | 19600.8 | 20084.6 | 19848.1 | 19852.9 |
| 308 | 19618.3 | 20098.5 | 19864.2 | 19868.7 |
| 309 | 19634.6 | 20116.8 | 19880.8 | 19884.5 |
| 310 | 19646.9 | 20138.6 | 19896.6 | 19899.9 |
| 311 | 19669.4 | 20150.4 | 19911.3 | 19915.1 |
| 312 | 19690.1 | 20161.2 | 19927.3 | 19930.3 |
| 313 | 19708.6 | 20174.6 | 19943.4 | 19945.5 |
| 314 | 19724.3 | 20189.9 | 19960.4 | 19961.4 |
| 315 | 19737.7 | 20206.9 | 19975.1 | 19976.9 |
| 316 | 19763.2 | 20218.3 | 19990.9 | 19993 |
| 317 | 19782.5 | 20229.7 | 20007 | 20008.9 |
| 318 | 19800 | 20244.6 | 20024.4 | 20025.2 |
| 319 | 19813.1 | 20264.3 | 20041.1 | 20041.7 |
| 320 | 19826.4 | 20286.6 | 20056.9 | 20058 |
| 321 | 19844.3 | 20302.1 | 20073.2 | 20074.2 |
| 322 | 19861.1 | 20321.8 | 20089.3 | 20090.5 |
| 323 | 19872.2 | 20341.5 | 20103.7 | 20106.4 |
| 324 | 19884.9 | 20363.8 | 20118.9 | 20122.2 |
| 325 | 19890.9 | 20388.6 | 20132.6 | 20137.6 |
| 326 | 19910.6 | 20404.4 | 20149.1 | 20153.5 |
| 327 | 19928.2 | 20422.4 | 20164.9 | 20169.4 |
| 328 | 19940.5 | 20444.9 | 20179.7 | 20185.2 |
| 329 | 19953.5 | 20464 | 20195.2 | 20201.2 |
| 330 | 19964.3 | 20485.9 | 20210.6 | 20217 |

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| 331 | 19982.1 | 20501.3 | 20226.5 | 20232.7 |
| 332 | 20000 | 20519.4 | 20241.2 | 20248.4 |
| 333 | 20013.9 | 20538 | 20256 | 20264.3 |
| 334 | 20023.7 | 20559.3 | 20270.6 | 20280.3 |
| 335 | 20032.7 | 20583.9 | 20286.6 | 20296.1 |
| 336 | 20056 | 20599.3 | 20302.5 | 20312.4 |
| 337 | 20075.5 | 20613.9 | 20318.5 | 20328.9 |
| 338 | 20093.9 | 20632.1 | 20335.2 | 20345.7 |
| 339 | 20109.3 | 20648.3 | 20351 | 20362.1 |
| 340 | 20119.7 | 20677.8 | 20367.6 | 20378.7 |
| 341 | 20143.2 | 20693.9 | 20387 | 20397.5 |
| 342 | 20163.3 | 20714.3 | 20405.4 | 20416.8 |
| 343 | 20177.7 | 20738.6 | 20424 | 20436.2 |
| 344 | 20190.1 | 20767.6 | 20442.8 | 20455.7 |
| 345 | 20202.4 | 20800.4 | 20460.5 | 20474.8 |
| 346 | 20231.1 | 20826 | 20483.7 | 20497.9 |
| 347 | 20257.3 | 20860.2 | 20505.8 | 20520.8 |

## Table S5 Sedimentation rates

| cal yr BP | mm/year | cal yr BP | mm/year | cal yr BP | mm/year |
|---|---|---|---|---|---|
| 1.6 | 0.136649 | 9446 | 0.12207 | | |
| 367.5 | 0.111632 | 9855.6 | 0.109433 | 17173.9 | 0.091962 |
| 815.4 | 0.131648 | 10312.5 | 0.08809 | 17717.6 | 0.262743 |
| 1195.2 | 0.111259 | 10880.1 | 0.094518 | 17907.9 | 0.269251 |
| 1644.6 | 0.10755 | 11409.1 | 0.107619 | | |
| 2109.5 | 0.135391 | 11873.7 | 0.094536 | | |
| 2478.8 | 0.245459 | 12402.6 | 0.100261 | | |
| 2682.5 | 0.217486 | 12901.3 | 0.196541 | | |
| 2912.4 | 0.233754 | 13155.7 | 0.504541 | | |
| 3126.3 | 0.210349 | 13254.8 | 0.535332 | | |
| 3364 | 0.116986 | 13348.2 | 0.659631 | | |
| 3791.4 | 0.121743 | 13424 | 0.634518 | | |
| 4202.1 | 0.09203 | 13502.8 | 0.59312 | | |
| 4745.4 | 0.085866 | 13587.1 | 0.508647 | | |
| 5327.7 | 0.104102 | 13685.4 | 0.222816 | | |
| 5808 | 0.2457 | 13909.8 | 0.210704 | | |
| 6011.5 | 0.431406 | 14147.1 | 0.163026 | | |
| 6127.4 | 0.422654 | 14453.8 | 0.153704 | | |
| 6245.7 | 0.262192 | 14779.1 | 0.172712 | | |
| 6436.4 | 0.065677 | 15068.6 | 0.243309 | | |

| | | | |
|---|---|---|---|
| 7197.7 | 0.058486 | 15274.1 | 0.209293 |
| 8052.6 | 0.068129 | 15513 | 0.062267 |
| 8786.5 | 0.14997 | 16316 | 0.058282 |
| 9119.9 | 0.153327 | | |

**Table S6 Pollen, spore, and other palynomorphs counts**

Highlighted samples were plotted in diagrams of Figs. 5 and 6 in main manuscript.

| Depth sample | 0cm | 5cm | 20cm | 25cm | 30cm | 35 cm | 40cm | 45cm | 50cm |
|---|---|---|---|---|---|---|---|---|---|
| Cal yr BP | 1.6 | 367.5 | 1644.6 | 2109.5 | 2478.8 | 2682.5 | 2912.4 | 3126.3 | 3364 |
| *Pinus* | 16 | 13 | 5 | 22 | 37 | 23 | 11 | 29 | 19 |
| *Picea* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cuppressaceae | 9 | 5 | 1 | 4 | 3 | 2 | 0 | 0 | 2 |
| *Salix* | 0 | 0 | 0 | 3 | 0 | 1 | 1 | 0 | 0 |
| *Populus* | 0 | 2 | 0 | 1 | 0 | 1 | 2 | 1 | 2 |
| *Juglans* | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Carya* | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 |
| *Alnus* | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| *Ostrya-Carpinus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Quercus* | 43 | 26 | 36 | 31 | 11 | 33 | 15 | 38 | 25 |
| *Ulmus* | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| *Celtis* | 4 | 4 | 6 | 2 | 5 | 4 | 3 | 0 | 0 |
| Moraceae | 1 | 1 | 2 | 1 | 0 | 3 | 2 | 2 | 0 |
| *Vitis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Tilia* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pyrus type | 0 | 2 | 0 | 2 | 0 | 1 | 0 | 1 | 0 |
| Liquidambar | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mimosa-Acacia | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Rhus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| *Acer* | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| Rhamnaceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Cornus* | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 5 |
| Ericaceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Fraxinus* | 1 | 1 | 5 | 2 | 0 | 1 | 1 | 1 | 4 |
| *Ephedra* | 0 | 0 | 0 | 3 | 2 | 1 | 1 | 1 | 2 |
| *Urtica type* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Chenopodiaceae | 10 | 6 | 6 | 3 | 4 | 3 | 2 | 3 | 10 |
| Caryophyllaceae | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 |
| Opuntia | 0 | 3 | 1 | 2 | 0 | 0 | 0 | 0 | 4 |
| *Eriogonum type* | 0 | 3 | 0 | 4 | 2 | 4 | 2 | 2 | 3 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Polygonum amphibius type | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ranunculaceae | 0 | 0 | 3 | 1 | 0 | 1 | 0 | 0 | 0 |
| Saxifragaceae/Ribes | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Berberidaceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Papaveraceae | 0 | 0 | 3 | 3 | 0 | 0 | 0 | 0 | 0 |
| Cruciferae | 3 | 1 | 0 | 2 | 0 | 1 | 0 | 0 | 0 |
| Rosaceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Trifolium type | 2 | 3 | 10 | 6 | 6 | 3 | 3 | 2 | 1 |
| Medicago | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Other Fabs | 6 | 5 | 2 | 4 | 0 | 7 | 2 | 2 | 5 |
| Oxalis | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Geraniaceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Linum type | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Euphorbiaceae | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 1 |
| Malvaceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Umbelliferae | 0 | 1 | 3 | 12 | 8 | 1 | 4 | 7 | 1 |
| Onagraceae | 0 | 0 | 0 | 5 | 3 | 2 | 0 | 0 | 0 |
| Solanaceae | 3 | 0 | 3 | 3 | 1 | 0 | 0 | 0 | 1 |
| Convolvulaceae | 0 | 0 | 0 | 1 | 0 | 4 | 0 | 0 | 2 |
| Boraginaceae | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Salvia type | 2 | 3 | 2 | 2 | 0 | 0 | 1 | 0 | 0 |
| Rubiaceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Artemisia | 0 | 2 | 0 | 5 | 4 | 4 | 2 | 2 | 5 |
| Serratula type | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ambrosia-type | 16 | 10 | 15 | 5 | 6 | 16 | 6 | 7 | 5 |
| Aster type | 3 | 4 | 26 | 18 | 14 | 48 | 45 | 38 | 32 |
| Cirsium type | 2 | 1 | 1 | 2 | 4 | 12 | 5 | 4 | 3 |
| Asteraceae liguliflorae | 2 | 0 | 2 | 5 | 0 | 4 | 4 | 10 | 5 |
| Other herbs | 13 | 15 | 41 | 27 | 8 | 37 | 1 | 13 | 27 |
| Poaceae | 9 | 8 | 9 | 12 | 0 | 7 | 7 | 7 | 4 |
| Liliaceae | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2 | 0 |
| Cyperaceae | 3 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| Typhaceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Juncaceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bryophytes | 28 | 6 | 15 | 9 | 12 | 9 | 7 | 5 | 10 |
| Polypodaceae | | | 1 | 1 | | 2 | 1 | 4 | 1 |
| Other spores | 152 | 183 | 162 | 140 | 155 | 200 | 49 | 98 | 142 |
| Cladosporium | | 234 | 213 | 253 | 140 | 76 | 17 | 17 | 45 |
| Mycorrhizae | 7 | 240 | 180 | 76 | 181 | 45 | 11 | 15 | 22 |
| Pseudoschizera | 10 | 3 | 4 | 11 | 10 | 23 | | 2 | 8 |
| Non identified fungal spores | 144 | 439 | 6 | 15 | 26 | 69 | 7 | 17 | 16 |
| *Sporormiella* | 35 | 10 | 4 | | 2 | 1 | 1 | 2 | 2 |

| Depth sample | 55cm | 60cm | 65cm | 70cm | 75cm | 80cm | 85cm | 90cm | 95cm |
|---|---|---|---|---|---|---|---|---|---|
| Cal yr BP | 3791 | 4202.1 | 4745.4 | 5327.7 | 5808 | 6011.5 | 6127.4 | 6245.7 | 6436.4 |
| *Pinus* | 102 | 24 | 20 | 28 | 6 | 8 | 22 | 13 | 16 |
| *Picea* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cuppressaceae | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| *Salix* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| *Populus* | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 2 | 0 |
| *Juglans* | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| *Carya* | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| *Alnus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Ostrya-Carpinus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Quercus* | 21 | 12 | 12 | 11 | 11 | 16 | 16 | 18 | 32 |
| *Ulmus* | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| *Celtis* | 3 | 3 | 1 | 0 | 0 | 0 | 4 | 0 | 0 |
| Moraceae | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 19 | 0 |
| *Vitis* | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| *Tilia* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pyrus type | 5 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 |
| Liquidambar | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mimosa-Acacia | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| *Rhus* | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| *Acer* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rhamnaceae | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 0 | 0 |
| *Cornus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ericaceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Fraxinus* | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| *Ephedra* | 11 | 0 | 0 | 1 | 0 | 0 | 4 | 1 | 1 |
| *Urtica type* | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| Chenopodiaceae | 23 | 4 | 0 | 1 | 2 | 10 | 5 | 3 | 10 |
| Caryophyllaceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 |
| Opuntia | 0 | 1 | 3 | 4 | 0 | 11 | 0 | 8 | 13 |
| *Eriogonum type* | 22 | 5 | 4 | 0 | 0 | 2 | 7 | 0 | 1 |
| Polygonum amphibius type | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ranunculaceae | 0 | 2 | 0 | 1 | 6 | 0 | 1 | 0 | 1 |
| Saxifragaceae/Ribes | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Berberidaceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Papaveraceae | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| Cruciferae | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| Rosaceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Trifolium type | 2 | 4 | 12 | 8 | 0 | 7 | 0 | 10 | 6 |
| Medicago | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Other Fabs | 15 | 10 | 2 | 0 | 1 | 3 | 8 | 2 | 5 |
| Oxalis | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Geraniaceae | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| Linum type | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Euphorbiaceae | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| Malvaceae | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 |
| Umbelliferae | 2 | 8 | 6 | 11 | 2 | 10 | 8 | 13 | 18 |
| Onagraceae | 0 | 7 | 4 | 7 | 4 | 6 | 9 | 12 | 9 |
| Solanaceae | 4 | 1 | 2 | 0 | 2 | 2 | 3 | 6 | 8 |
| Convolvulaceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Boraginaceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Salvia type | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| Rubiaceae | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Artemisia | 15 | 4 | 4 | 0 | 1 | 1 | 4 | 2 | 8 |
| Serratula type | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16 |
| Ambrosia-type | 51 | 5 | 9 | 17 | 11 | 11 | 11 | 15 | 0 |
| Aster type | 16 | 12 | 10 | 33 | 36 | 31 | 12 | 34 | 64 |
| Cirsium type | 5 | 3 | 1 | 6 | 1 | 0 | 2 | 2 | 4 |
| Asteraceae liguliflorae | 4 | 12 | 28 | 7 | 8 | 11 | 20 | 30 | 30 |
| Other herbs | 32 | 22 | 0 | 29 | 22 | 28 | 30 | 27 | 66 |
| Poaceae | 20 | 5 | 0 | 3 | 4 | 3 | 11 | 4 | 8 |
| Liliaceae | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 2 | 0 |
| Cyperaceae | 4 | 0 | 0 | 0 | 0 | 0 | 1 | 4 | 3 |
| Typhaceae | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Juncaceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bryophytes | 38 | 9 | 13 | 4 | 4 | 2 | 17 | 13 | 9 |
| Polypodaceae | 5 | | | 1 | | | | | 2 |
| Other spores | 57 | 135 | 107 | 230 | 34 | 154 | 261 | 155 | 136 |
| Cladosporium | | 148 | 97 | 3 | 2 | 4 | 38 | 8 | 220 |
| Mycorrhizae | | 54 | 31 | 3 | 12 | 7 | | 49 | 154 |
| Pseudoschizera | | 6 | 4 | 7 | 2 | | 5 | 3 | |
| Non identified fungal spores | 4 | 11 | 10 | 2 | 4 | 1 | 4 | 2 | 2 |
| *Sporormiella* | | | 6 | | 1 | 2 | | 1 | |
| | | | | | | | | | |
| Depth sample | 100cm | 105cm | 110cm | 115cm | 120cm | 125cm | 130cm | 135cm | 140cm |
| Cal yr BP | 7198 | 8052.6 | 8786.5 | 9119.9 | 9446 | 9855.6 | 10312.5 | 10880 | 11409 |
| *Pinus* | 27 | 14 | 12 | 12 | 11 | 9 | 22 | 42 | 41 |
| *Picea* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cuppressaceae | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 |
| *Salix* | 0 | 2 | 1 | 0 | 2 | 0 | 0 | 1 | 2 |
| *Populus* | 0 | 1 | 0 | 3 | 0 | 0 | 0 | 0 | 3 |
| *Juglans* | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 |
| *Carya* | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Alnus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *Ostrya-Carpinus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Quercus* | 20 | 27 | 8 | 14 | 13 | 3 | 32 | 19 | 24 |
| *Ulmus* | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 1 | 0 |
| *Celtis* | 0 | 1 | 2 | 0 | 1 | 1 | 2 | 3 | 4 |
| Moraceae | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| *Vitis* | 0 | 0 | 0 | 0 | 1 | 0 | 4 | 0 | 0 |
| *Tilia* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Pyrus type | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 2 |
| Liquidambar | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mimosa-Acacia | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Rhus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| *Acer* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rhamnaceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Cornus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ericaceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Fraxinus* | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 5 |
| *Ephedra* | 0 | 0 | 2 | 1 | 0 | 1 | 1 | 4 | 0 |
| *Urtica type* | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Chenopodiaceae | 3 | 0 | 10 | 2 | 5 | 0 | 4 | 5 | 0 |
| Caryophyllaceae | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |
| Opuntia | 13 | 10 | 6 | 14 | 9 | 0 | 1 | 0 | 0 |
| *Eriogonum type* | 6 | 5 | 2 | 4 | 0 | 0 | 0 | 0 | 0 |
| Polygonum amphibius type | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ranunculaceae | 1 | 1 | 0 | 0 | 5 | 0 | 2 | 6 | 0 |
| Saxifragaceae/Ribes | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Berberidaceae | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Papaveraceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 |
| Cruciferae | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Rosaceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Trifolium type | 0 | 3 | 4 | 2 | 3 | 0 | 4 | 3 | 5 |
| Medicago | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Other Fabs | 1 | 2 | 4 | 1 | 1 | 0 | 7 | 9 | 6 |
| Oxalis | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Geraniaceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Linum type | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Euphorbiaceae | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| Malvaceae | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Umbelliferae | 21 | 26 | 36 | 18 | 7 | 2 | 7 | 2 | 9 |
| Onagraceae | 13 | 15 | 0 | 9 | 7 | 0 | 6 | 2 | 0 |
| Solanaceae | 1 | 2 | 0 | 0 | 1 | 0 | 6 | 0 | 1 |
| Convolvulaceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Boraginaceae | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| Salvia type | 0 | 1 | 0 | 1 | 0 | 0 | 2 | 0 | 0 |
| Rubiaceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Artemisia | 4 | 8 | 2 | 5 | 2 | 0 | 9 | 22 | 5 |
| Serratula type | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ambrosia-type | 7 | 9 | 10 | 10 | 8 | 2 | 40 | 27 | 11 |
| Aster type | 59 | 44 | 38 | 47 | 32 | 5 | 8 | 42 | 33 |
| Cirsium type | 7 | 4 | 2 | 2 | 3 | 0 | 7 | 4 | 2 |
| Asteraceae liguliflorae | 29 | 30 | 0 | 22 | 37 | 4 | 41 | 6 | 5 |
| Other herbs | 31 | 54 | 0 | 13 | 17 | 2 | 19 | 68 | 36 |
| Poaceae | 4 | 6 | 2 | 6 | 4 | 4 | 9 | 9 | 13 |
| Liliaceae | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cyperaceae | 0 | 0 | 1 | 0 | 1 | 0 | 2 | 1 | 0 |
| Typhaceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Juncaceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bryophytes | 2 | 5 | 2 | 6 | 6 | 2 | 4 | 6 | 4 |
| Polypodaceae | | 1 | | 4 | | | 1 | 2 | 9 |
| Other spores | 74 | 114 | 98 | 111 | 47 | | 113 | 129 | 90 |
| Cladosporium | | 1 | 3 | 1 | | | | 1 | |
| Mycorrhizae | | 1 | 168 | | | | 2 | 3 | 27 |
| Pseudoschizera | | | | 1 | | | | 1 | 13 |
| Non identified fungal spores | | 1 | 1 | | 6 | 28 | 2 | 3 | 46 |
| *Sporormiella* | | | | 1 | | | | | 4 |

| Depth sample | 145cm | 150cm | 155cm | 160cm | 165cm | 170cm | 175cm | 180cm | 185cm |
|---|---|---|---|---|---|---|---|---|---|
| Cal yr BP | 11874 | 12403 | 12901 | 13155.7 | 13255 | 13348 | 13424 | 13503 | 13587 |
| *Pinus* | 5 | 16 | 43 | 37 | 68 | 47 | 102 | 28 | 54 |
| *Picea* | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 2 | 9 |
| Cuppressaceae | 2 | 0 | 0 | 3 | 0 | 1 | 0 | 0 | 1 |
| *Salix* | 1 | 0 | 1 | 7 | 0 | 0 | 1 | 1 | 0 |
| *Populus* | 0 | 0 | 0 | 2 | 0 | 2 | 2 | 0 | 3 |
| *Juglans* | 0 | 0 | 7 | 9 | 15 | 5 | 4 | 2 | 1 |
| *Carya* | 0 | 0 | 2 | 1 | 0 | 0 | 3 | 1 | 0 |
| *Alnus* | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 |
| *Ostrya-Carpinus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 |
| *Quercus* | 30 | 10 | 19 | 17 | 9 | 9 | 9 | 25 | 15 |
| *Ulmus* | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 1 | 0 |
| *Celtis* | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 |
| Moraceae | 2 | 1 | 0 | 2 | 2 | 0 | 0 | 0 | 2 |
| *Vitis* | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| *Tilia* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pyrus type | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 1 |
| Liquidambar | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Mimosa-Acacia | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Rhus* | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| *Acer* | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 3 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Rhamnaceae | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Cornus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ericaceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Fraxinus* | 2 | 1 | 2 | 3 | 0 | 0 | 0 | 0 | 0 |
| *Ephedra* | 2 | 1 | 5 | 2 | 1 | 0 | 3 | 3 | 2 |
| *Urtica type* | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| Chenopodiaceae | 3 | 10 | 8 | 12 | 5 | 4 | 7 | 9 | 13 |
| Caryophyllaceae | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 0 |
| Opuntia | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Eriogonum type* | 0 | 4 | 5 | 3 | 5 | 1 | 1 | 1 | 0 |
| Polygonum amphibius type | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| Ranunculaceae | 0 | 5 | 0 | 3 | 2 | 1 | 1 | 3 | 1 |
| Saxifragaceae/Ribes | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 8 |
| Berberidaceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Papaveraceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cruciferae | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Rosaceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Trifolium type | 2 | 1 | 1 | 1 | 2 | 0 | 0 | 12 | 1 |
| Medicago | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Other Fabs | 21 | 5 | 3 | 4 | 0 | 0 | 4 | 4 | 0 |
| Oxalis | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 6 |
| Geraniaceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Linum type | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 |
| Euphorbiaceae | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Malvaceae | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| Umbelliferae | 0 | 1 | 2 | 1 | 1 | 0 | 1 | 9 | 3 |
| Onagraceae | 0 | 9 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| Solanaceae | 0 | 3 | 2 | 2 | 4 | 0 | 0 | 3 | 1 |
| Convolvulaceae | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 0 |
| Boraginaceae | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| Salvia type | 2 | 0 | 1 | 2 | 1 | 0 | 0 | 2 | 0 |
| Rubiaceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1 |
| Artemisia | 17 | 6 | 6 | 5 | 2 | 1 | 11 | 0 | 3 |
| Serratula type | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ambrosia-type | 4 | 7 | 19 | 41 | 16 | 12 | 22 | 13 | 5 |
| Aster type | 27 | 35 | 33 | 29 | 35 | 7 | 21 | 19 | 10 |
| Cirsium type | 1 | 5 | 9 | 3 | 5 | 0 | 0 | 4 | 5 |
| Asteraceae liguliflorae | 16 | 43 | 11 | 8 | 26 | 7 | 8 | 19 | 1 |
| Other herbs | 54 | 30 | 4 | 22 | 10 | 7 | 20 | 47 | 22 |
| Poaceae | 15 | 4 | 5 | 4 | 8 | 5 | 7 | 12 | 15 |
| Liliaceae | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 2 | 1 |
| Cyperaceae | 1 | 1 | 8 | 8 | 4 | 3 | 1 | 4 | 6 |
| Typhaceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Juncaceae | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 1 | 0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Bryophytes | 8 | 3 | 12 | 8 | 17 | 5 | 7 | 6 | 22 |
| Polypodaceae | 5 | 4 | 14 | 10 | 6 | 5 | 3 | 4 | 8 |
| Other spores | 130 | 82 | 61 | 40 | 9 | 53 | 75 | 177 | 62 |
| Cladosporium | 3 | | | | | | 4 | | |
| Mycorrhizae | | | | 2 | | | 8 | | 1 |
| Pseudoschizera | 3 | | | 3 | 2 | 1 | | | 4 |
| Non identified fungal spores | 58 | 1 | 4 | | | | 5 | | 2 |
| *Sporormiella* | 3 | | | | | | 1 | | |

| Depth sample | 190cm | 195cm | 205cm | 215cm | 230cm | 235cm | 240cm | 245cm | 250cm |
|---|---|---|---|---|---|---|---|---|---|
| Cal yr BP | 13685 | 13910 | 14454 | 15068.6 | 16316 | 17174 | 17717.6 | 17908 | 18094 |
| *Pinus* | 130 | 103 | 18 | 57 | 59 | 25 | 15 | 18 | 13 |
| *Picea* | 4 | 3 | 0 | 2 | 1 | 0 | 0 | 1 | 1 |
| Cuppressaceae | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 2 |
| *Salix* | 0 | 0 | 1 | 2 | 7 | 3 | 0 | 2 | 3 |
| *Populus* | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 |
| *Juglans* | 3 | 3 | 0 | 0 | 1 | 1 | 1 | 0 | 0 |
| *Carya* | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Alnus* | 1 | 0 | 0 | 0 | 1 | 2 | 1 | 4 | 4 |
| *Ostrya-Carpinus* | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 |
| *Quercus* | 8 | 3 | 6 | 11 | 7 | 9 | 5 | 11 | 6 |
| *Ulmus* | 2 | 1 | 3 | 1 | 1 | 0 | 0 | 0 | 0 |
| *Celtis* | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 |
| Moraceae | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Vitis* | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| *Tilia* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Pyrus type | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 |
| Liquidambar | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Mimosa-Acacia | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Rhus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Acer* | 1 | 0 | 0 | 2 | 3 | 3 | 0 | 0 | 1 |
| Rhamnaceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Cornus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ericaceae | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| *Fraxinus* | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| *Ephedra* | 3 | 3 | 0 | 1 | 1 | 1 | 0 | 2 | 0 |
| *Urtica type* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| Chenopodiaceae | 9 | 4 | 1 | 7 | 6 | 11 | 3 | 16 | 16 |
| Caryophyllaceae | 0 | 1 | 1 | 8 | 6 | 6 | 0 | 0 | 5 |
| Opuntia | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Eriogonum type* | 17 | 6 | 3 | 0 | 2 | 1 | 0 | 0 | 0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Polygonum amphibius type | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ranunculaceae | 0 | 0 | 3 | 2 | 5 | 2 | 0 | 0 | 0 |
| Saxifragaceae/Ribes | 10 | 1 | 1 | 4 | 0 | 1 | 0 | 0 | 0 |
| Berberidaceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Papaveraceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cruciferae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rosaceae | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| Trifolium type | 3 | 0 | 0 | 4 | 7 | 3 | 4 | 9 | 1 |
| Medicago | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Other Fabs | 0 | 0 | 1 | 2 | 3 | 5 | 1 | 1 | 2 |
| Oxalis | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Geraniaceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Linum type | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Euphorbiaceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Malvaceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Umbelliferae | 2 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| Onagraceae | 0 | 0 | 0 | 2 | 0 | 0 | 2 | 1 | 1 |
| Solanaceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Convolvulaceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Boraginaceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| Salvia type | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 |
| Rubiaceae | 1 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Artemisia | 2 | 4 | 6 | 11 | 22 | 30 | 7 | 21 | 17 |
| Serratula type | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ambrosia-type | 9 | 3 | 7 | 15 | 10 | 12 | 5 | 11 | 26 |
| Aster type | 0 | 7 | 5 | 16 | 29 | 32 | 10 | 52 | 55 |
| Cirsium type | 4 | 0 | 1 | 7 | 11 | 4 | 0 | 2 | 4 |
| Asteraceae liguliflorae | 2 | 2 | 5 | 18 | 23 | 9 | 11 | 14 | 6 |
| Other herbs | 6 | 5 | 4 | 9 | 31 | 27 | 7 | 20 | 45 |
| Poaceae | 11 | 13 | 7 | 17 | 9 | 0 | 8 | 6 | 8 |
| Liliaceae | 2 | 1 | 2 | 2 | 0 | 0 | 0 | 1 | 5 |
| Cyperaceae | 21 | 11 | 8 | 21 | 18 | 8 | 8 | 29 | 30 |
| Typhaceae | 2 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 |
| Juncaceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bryophytes | 15 | 10 | 6 | 15 | 14 | 13 | 6 | 5 | 11 |
| Polypodaceae | 14 | 10 | 15 | 121 | 41 | 132 | 6 | 31 | 26 |
| Other spores | 31 | 42 | | 57 | 28 | 50 | 18 | 20 | 19 |
| Cladosporium | | | | 1 | | | | | |
| Mycorrhizae | | 1 | 1 | 20 | 1 | 12 | 3 | | |
| Pseudoschizera | 9 | 4 | 2 | 21 | 8 | 14 | | 1 | 2 |
| Non identified fungal spores | | 7 | 2 | 9 | 3 | 15 | 4 | 4 | 4 |
| *Sporormiella* | 1 | 5 | 9 | 5 | 1 | 8 | 1 | 3 | 4 |

## Table S7 Charcoal concentration

| depth | cal yr BP | Charcoal area mm/g sedim |
|---|---|---|
| -5 | 0 | 2.826597813 |
| 0 | 1.6 | 3.931519736 |
| 5 | 367.5 | 16.22640973 |
| 10 | 815.4 | 33.28098989 |
| 15 | 1195.2 | 26.12946809 |
| 20 | 1644.6 | 6.488024929 |
| 25 | 2109.5 | 0.90040497 |
| 30 | 2478.8 | 2.525073489 |
| 35 | 2682.5 | 1.382347951 |
| 40 | 2912.4 | 0.442358982 |
| 45 | 3126.3 | 3.043400908 |
| 50 | 3364 | 7.792639072 |
| 55 | 3791.4 | 0.137725198 |
| 60 | 4202.1 | 5.199666346 |
| 65 | 4745.4 | 7.653043527 |
| 70 | 5327.7 | 0.88910912 |
| 75 | 5808 | 1.262649914 |
| 80 | 6011.5 | 1.322101566 |
| 85 | 6127.4 | 0.503833227 |
| 90 | 6245.7 | 3.596244931 |
| 95 | 6436.4 | 0.461110217 |
| 100 | 7197.7 | 0.270964664 |
| 105 | 8052.6 | 0.341958719 |
| 110 | 8786.5 | 0.330235817 |
| 115 | 9119.9 | 2.273805538 |
| 120 | 9446 | 0.988608425 |
| 125 | 9855.6 | 0.631031818 |
| 130 | 10312.5 | 0.315272881 |
| 135 | 10880.1 | 0.310083786 |
| 140 | 11409.1 | 0.877091397 |
| 145 | 11873.7 | 0.117758542 |
| 150 | 12402.6 | 0.245844559 |
| 155 | 12901.3 | 0.255940705 |
| 160 | 13155.7 | 2.437719061 |
| 165 | 13254.8 | 0.455934535 |
| 170 | 13348.2 | 0.562989664 |
| 175 | 13424 | 0.21175453 |
| 180 | 13502.8 | 0.134055532 |
| 185 | 13587.1 | 0.131560185 |
| 190 | 13685.4 | 0.147704011 |
| 195 | 13909.8 | 0.047684081 |
| 205 | 14453.8 | 0.063737275 |
| 215 | 15068.6 | 0.04921784 |
| 230 | 16316 | 0.227263665 |
| 235 | 17173.9 | 0.178402118 |

| | | |
|---|---|---|
| 240 | 17717.6 | 0.106418053 |
| 245 | 17907.9 | 0.019923507 |
| 250 | 18093.6 | 0.123854381 |

## Table S8 PCA eigenvalues, percent variance, and loadings for PC1 and PC2 axes

Yellow highlights indicate used data

| PC | Eigenvalue | % variance | AGE | PC 1 | PC 2 |
|---|---|---|---|---|---|
| 1 | 926.344 | 47.392 | 1.6 | -12.244 | -26.89 |
| 2 | 376.971 | 19.286 | 367.5 | -15.305 | -27.174 |
| 3 | 184.427 | 9.4353 | 1644.6 | -25.57 | -8.8291 |
| 4 | 120.799 | 6.1801 | 2109.5 | -9.5725 | -13.623 |
| 5 | 89.6771 | 4.5879 | 2478.8 | 6.5041 | -13.33 |
| 6 | 86.7118 | 4.4362 | 2682.5 | -11.851 | 15.098 |
| 7 | 41.3048 | 2.1132 | 2912.4 | -22.523 | 8.4399 |
| 8 | 33.3154 | 1.7044 | 3126.3 | -7.3531 | 7.5596 |
| 9 | 22.1963 | 1.1356 | 3364 | -13.461 | -1.5724 |
| 10 | 16.2344 | 0.83055 | 3791.4 | 76.821 | 6.1384 |
| 11 | 9.94949 | 0.50902 | 4202.1 | -5.6088 | -18.166 |
| 12 | 8.02714 | 0.41067 | 4745.4 | -10.186 | -17.2 |
| 13 | 6.21132 | 0.31777 | 5327.7 | -3.8733 | 3.5628 |
| 14 | 5.7285 | 0.29307 | 5808 | -25.266 | 0.2962 |
| 15 | 5.26054 | 0.26913 | 6011.5 | -24.119 | -1.3294 |
| 16 | 4.72255 | 0.24161 | 6127.4 | -7.7569 | -15.645 |
| 17 | 3.12288 | 0.15977 | 6245.7 | -22.41 | 7.0423 |
| 18 | 2.71703 | 0.139 | 6436.4 | -25.901 | 36.998 |
| 19 | 1.90701 | 0.097562 | 7197.7 | -14.345 | 32.912 |
| 20 | 1.60189 | 0.081953 | 8052.6 | -25.248 | 18.144 |
| 21 | 1.50106 | 0.076794 | 8786.5 | -23.444 | 8.7952 |
| 22 | 1.34577 | 0.06885 | 9119.9 | -24.79 | 17.392 |
| 23 | 0.793912 | 0.040617 | 9446 | -24.141 | 4.0219 |
| 24 | 0.73843 | 0.037778 | 9855.6 | -16.749 | -29.358 |
| 25 | 0.575756 | 0.029456 | 10312.5 | -8.6128 | -11.107 |
| 26 | 0.506237 | 0.025899 | 10880.1 | 10.107 | 16.238 |
| 27 | 0.454446 | 0.023249 | 11409.1 | 7.9817 | 4.7851 |
| 28 | 0.347975 | 0.017802 | 11873.7 | -27.854 | -5.3537 |
| 29 | 0.284177 | 0.014538 | 12402.6 | -19.557 | 8.397 |
| 30 | 0.234165 | 0.01198 | 12901.3 | 10.871 | 6.8662 |
| 31 | 0.14161 | 0.007245 | 13155.7 | 8.382 | 4.5571 |
| 32 | 0.106302 | 0.005438 | 13254.8 | 33.49 | 14.968 |

| | | | | | |
|---|---|---|---|---|---|
| 33 | 0.0745135 | 0.003812 | 13348.2 | 18.569 | -18.744 |
| 34 | 0.0654645 | 0.003349 | 13424 | 70.906 | 6.0414 |
| 35 | 0.0600546 | 0.003072 | 13502.8 | -3.9818 | -7.3018 |
| 36 | 0.0484809 | 0.00248 | 13587.1 | 25.871 | -16.991 |
| 37 | 0.0395581 | 0.002024 | 13685.4 | 97.477 | 13.563 |
| 38 | 0.0328123 | 0.001679 | 13909.8 | 74.029 | -11.733 |
| 39 | 0.0286846 | 0.001468 | 14453.8 | -8.6566 | -26.782 |
| 40 | 0.0169135 | 0.000865 | 15068.6 | 26.823 | -5.3452 |
| 41 | 0.0117535 | 0.000601 | 16316 | 25.945 | 7.9129 |
| 42 | 0.00650757 | 0.000333 | 17173.9 | -5.9063 | 3.9681 |
| 43 | 0.00495402 | 0.000253 | 17717.6 | -12.828 | -21.746 |
| 44 | 0.00261925 | 0.000134 | 17907.9 | -16.481 | 21.729 |
| | | | 18093.6 | -18.181 | 22.793 |

## Table S9 Phytolith counts

| Depth | -5 | 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 |
|---|---|---|---|---|---|---|---|---|---|
| cal yr BP | 0 | 730 | 920 | 1140 | 1380 | 1640 | 1930 | 2230 | 2560 |
| POACEAE | | | | | | | | | |
| Diagnostic short cells | 123 | 67 | 85 | 59 | 65 | 82 | 20 | 28 | 16 |
| Other non-diagnostic | 48 | 24 | 37 | 38 | 40 | 45 | 26 | 22 | 11 |
| Total short cells | 171 | 91 | 122 | 97 | 105 | 127 | 46 | 50 | 27 |
| Smooth | 21 | 10 | 12 | 11 | 3 | 9 | 2 | 3 | 6 |
| Sinuous | 6 | 1 | 2 | 0 | 1 | 0 | 1 | 0 | 0 |
| Serrated | 2 | 8 | 6 | 5 | 8 | 4 | 1 | 2 | 3 |
| Echinate | 1 | 6 | 5 | 5 | 2 | 2 | 1 | 2 | 0 |
| Dendritic | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 |
| Total elongates | 30 | 26 | 26 | 21 | 14 | 15 | 5 | 8 | 9 |
| Long point | 2 | 17 | 12 | 18 | 21 | 19 | 14 | 12 | 13 |
| Short pointy | 10 | 15 | 14 | 10 | 11 | 10 | 9 | 3 | 8 |
| Total pointy | 12 | 32 | 26 | 28 | 32 | 29 | 23 | 15 | 21 |
| Fan-bamboo | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Fan-reed | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Fan | 4 | 14 | 15 | 17 | 13 | 16 | 21 | 34 | 29 |
| Fan/Keystone shaped | 4 | 14 | 15 | 18 | 13 | 16 | 21 | 34 | 29 |
| Square | 6 | 23 | 10 | 18 | 20 | 19 | 44 | 38 | 23 |
| Rectangular | 3 | 29 | 20 | 28 | 12 | 20 | 23 | 23 | 19 |
| Broad elongate | 5 | 15 | 20 | 23 | 19 | 26 | 14 | 27 | 11 |
| Total parallelepipedal | 14 | 67 | 50 | 69 | 51 | 65 | 81 | 88 | 53 |
| Total Bulliforms | 18 | 81 | 65 | 87 | 64 | 81 | 102 | 122 | 82 |
| Undetermined | 12 | 25 | 27 | 32 | 35 | 21 | 49 | 53 | 32 |
| TOTAL GRASS | 243 | 255 | 266 | 265 | 250 | 273 | 225 | 248 | 171 |
| CYPERACEAE | | | | | | | | | |
| Cyperaceae Achenes | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cyperaceae-type papillae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| TOTAL CYPERACEAE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **TOTAL GRAMINOID** | 243 | 255 | 266 | 265 | 250 | 273 | 225 | 248 | 171 |
| | | | | | | | | | |
| NON-GRAMINOID | | | | | | | | | |
| Asteraceae platelets | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Celtis type | 3 | 29 | 11 | 12 | 1 | 0 | 1 | 0 | 1 |
| Blocky | 48 | 10 | 41 | 44 | 76 | 107 | 75 | 36 | 68 |
| Scalloped faceted | 1 | 8 | 9 | 3 | 11 | 2 | 17 | 19 | 68 |
| Globular | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Maclura type blocky hairbase | 0 | 1 | 1 | 0 | 4 | | 4 | 1 | 2 |
| Gobbet - irregular | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Other | 35 | 27 | 45 | 82 | 116 | 105 | 112 | 45 | 102 |
| **TOTAL NON-GRAMINOID** | 87 | 76 | 108 | 141 | 208 | 214 | 209 | 101 | 242 |
| TOTAL PHYTOLITHS COUNTED | 330 | 331 | 374 | 406 | 458 | 487 | 434 | 349 | 413 |
| | | | | | | | | | |
| Depth | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 |
| cal yr BP | 2900 | 3250 | 3620 | 4000 | 4400 | 4800 | 5200 | 5620 | 6040 |
| POACEAE | | | | | | | | | |
| Diagnostic short cells | 4 | 15 | 3 | 9 | 4 | 3 | 3 | 5 | 5 |
| Other non-diagnostic | 3 | 8 | 3 | 3 | 2 | 1 | 0 | 3 | 1 |
| Total short cells | 7 | 23 | 6 | 12 | 6 | 4 | 3 | 8 | 6 |
| Smooth | 2 | 5 | 3 | 1 | 0 | 1 | 0 | 0 | 0 |
| Sinuous | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| Serrated | 3 | 3 | 1 | 3 | 0 | 0 | 0 | 0 | 0 |
| Echinate | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dendritic | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total elongates | 5 | 11 | 5 | 5 | 0 | 1 | 0 | 0 | 0 |
| Long point | 3 | 4 | 2 | 6 | 1 | 2 | 0 | 2 | 1 |
| Short pointy | 3 | 1 | 1 | 1 | 2 | 2 | 0 | 0 | 1 |
| Total pointy | 6 | 5 | 3 | 7 | 3 | 4 | 0 | 2 | 2 |
| Fan-bamboo | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Fan-reed | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Fan | 11 | 11 | 3 | 5 | 5 | 3 | 2 | 2 | 4 |
| Fan/Keystone shaped | 11 | 11 | 3 | 5 | 5 | 3 | 2 | 2 | 4 |
| Square | 4 | 10 | 2 | 5 | 3 | 5 | 3 | 2 | 4 |
| Rectangular | 12 | 22 | 4 | 7 | 4 | 3 | 4 | 3 | 4 |
| Broad elongate | 8 | 14 | 3 | 6 | 2 | 2 | 1 | 1 | 1 |
| Total parallelepipedal | 24 | 46 | 9 | 18 | 9 | 10 | 8 | 6 | 9 |
| Total Bulliforms | 35 | 57 | 12 | 23 | 14 | 13 | 10 | 8 | 13 |
| Undetermined | 7 | 21 | 12 | 10 | 8 | 1 | 2 | 1 | 1 |
| TOTAL GRASS | 60 | 117 | 38 | 57 | 31 | 23 | 15 | 19 | 22 |
| CYPERACEAE | | | | | | | | | |
| Cyperaceae Achenes | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cyperaceae-type papillae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL CYPERACEAE | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| **TOTAL GRAMINOID** | 60 | 117 | 40 | 57 | 31 | 23 | 15 | 19 | 22 |
| | | | | | | | | | |
| NON-GRAMINOID | | | | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Asteraceae platelets | 0 | 2 | 5 | 2 | 2 | 0 | 0 | 0 | 0 |
| Celtis type | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 2 | 0 |
| Blocky | 190 | 138 | 109 | 64 | 43 | 80 | 43 | 30 | 28 |
| Scalloped faceted | 97 | 60 | 148 | 76 | 120 | 49 | 30 | 23 | 54 |
| Globular | 0 | 2 | 0 | 3 | 1 | 3 | 0 | 2 | 4 |
| Maclura type blocky hairbase | | 1 | 1 | | | 1 | | | 2 |
| Gobbet - irregular | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| Other | 262 | 179 | 260 | 360 | 295 | 428 | 375 | 358 | 304 |
| **TOTAL NON-GRAMINOID** | 550 | 382 | 523 | 506 | 461 | 561 | 451 | 415 | 393 |
| TOTAL PHYTOLITHS COUNTED | 610 | 499 | 561 | 563 | 492 | 584 | 466 | 434 | 415 |
| | | | | | | | | | |
| Depth | 85 | 90 | 95 | 100 | 105 | 110 | 115 | 120 | 125 |
| cal yr BP | 6460 | 6890 | 7320 | 7750 | 8170 | 8600 | 9030 | 9450 | 9860 |
| POACEAE | | | | | | | | | |
| Diagnostic short cells | 8 | 2 | 10 | 5 | 0 | 6 | 6 | 3 | 5 |
| Other non-diagnostic | 4 | 3 | 6 | 3 | 4 | 4 | 3 | 6 | 6 |
| Total short cells | 12 | 5 | 16 | 8 | 4 | 10 | 9 | 9 | 11 |
| Smooth | 0 | 0 | 2 | 3 | 1 | 0 | 2 | 0 | 0 |
| Sinuous | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Serrated | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Echinate | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dendritic | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Total elongates | 0 | 1 | 3 | 3 | 1 | 1 | 2 | 0 | 0 |
| Long point | 1 | 1 | 3 | 1 | 0 | 2 | 1 | 1 | 0 |
| Short pointy | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 |
| Total pointy | 1 | 1 | 4 | 1 | 0 | 4 | 1 | 1 | 0 |
| Fan-bamboo | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Fan-reed | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Fan | 2 | 1 | 4 | 4 | 0 | 2 | 2 | 0 | 1 |
| Fan/Keystone shaped | 2 | 1 | 4 | 4 | 0 | 2 | 2 | 0 | 1 |
| Square | 3 | 1 | 4 | 2 | 0 | 1 | 2 | 1 | 1 |
| Rectangular | 1 | 1 | 5 | 1 | 3 | 1 | 1 | 0 | 2 |
| Broad elongate | 0 | 2 | 0 | 2 | 1 | 0 | 3 | 1 | 0 |
| Total parallelepipedal | 4 | 4 | 9 | 5 | 4 | 2 | 6 | 2 | 3 |
| Total Bulliforms | 6 | 5 | 13 | 9 | 4 | 4 | 8 | 2 | 4 |
| Undetermined | 3 | 2 | 4 | 1 | 3 | 3 | 3 | 5 | 1 |
| TOTAL GRASS | 22 | 14 | 40 | 22 | 12 | 22 | 23 | 17 | 16 |
| CYPERACEAE | | | | | | | | | |
| Cyperaceae Achenes | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cyperaceae-type papillae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL CYPERACEAE | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| **TOTAL GRAMINOID** | 23 | 14 | 41 | 22 | 12 | 22 | 23 | 17 | 16 |
| | | | | | | | | | |
| NON-GRAMINOID | | | | | | | | | |
| Asteraceae platelets | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 1 | 0 |
| Celtis type | 3 | 2 | 4 | 0 | 0 | 2 | 5 | 2 | 1 |
| Blocky | 43 | 20 | 79 | 65 | 102 | 83 | 39 | 38 | 49 |
| Scalloped faceted | 46 | 6 | 44 | 49 | 130 | 88 | 111 | 72 | 189 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Globular | | | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Maclura type blocky hairbase | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Gobbet - irregular | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Other | 297 | 336 | 395 | 331 | 390 | 351 | 390 | 272 | 330 |
| **TOTAL NON-GRAMINOID** | 390 | 366 | 523 | 445 | 624 | 526 | 546 | 385 | 569 |
| TOTAL PHYTOLITHS COUNTED | 412 | 380 | 563 | 467 | 636 | 548 | 569 | 402 | 585 |

| Depth | 130 | 135 | 140 | 145 | 150 | 155 | 160 | 165 | 170 |
|---|---|---|---|---|---|---|---|---|---|
| cal yr BP | 10280 | 10690 | 11090 | 11480 | 11870 | 12250 | 12620 | 12980 | 13330 |
| POACEAE | | | | | | | | | |
| Diagnostic short cells | 1 | 17 | 1 | 4 | 0 | 11 | 1 | 3 | 4 |
| Other non-diagnostic | 4 | 21 | 3 | 7 | 2 | 5 | 1 | 1 | 4 |
| Total short cells | 5 | 38 | 4 | 11 | 2 | 16 | 2 | 4 | 8 |
| Smooth | 1 | 0 | 2 | 1 | 1 | 1 | 0 | 0 | 0 |
| Sinuous | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Serrated | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 |
| Echinate | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dendritic | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total elongates | 1 | 5 | 2 | 1 | 1 | 4 | 0 | 0 | 0 |
| Long point | 1 | 0 | 0 | 1 | 0 | 3 | 0 | 1 | 1 |
| Short pointy | 1 | 1 | 0 | 0 | 2 | 1 | 0 | 0 | 0 |
| Total pointy | 2 | 1 | 0 | 1 | 2 | 4 | 0 | 1 | 1 |
| Fan-bamboo | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Fan-reed | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Fan | 2 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 |
| Fan/Keystone shaped | 2 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 |
| Square | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 2 |
| Rectangular | 1 | 1 | 1 | 0 | 1 | 3 | 0 | 1 | 1 |
| Broad elongate | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total parallelepipedal | 2 | 4 | 3 | 1 | 1 | 4 | 1 | 2 | 3 |
| Total Bulliforms | 4 | 4 | 4 | 2 | 2 | 5 | 2 | 2 | 4 |
| Undetermined | 3 | 5 | 4 | 2 | 2 | 8 | 1 | 0 | 2 |
| TOTAL GRASS | 15 | 53 | 14 | 17 | 9 | 37 | 5 | 7 | 15 |
| CYPERACEAE | | | | | | | | | |
| Cyperaceae Achenes | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cyperaceae-type papillae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL CYPERACEAE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **TOTAL GRAMINOID** | 15 | 53 | 14 | 17 | 9 | 37 | 5 | 7 | 15 |
| | | | | | | | | | |
| NON-GRAMINOID | | | | | | | | | |
| Asteraceae platelets | 2 | 2 | 2 | 5 | 13 | 0 | 1 | 2 | 0 |
| Celtis type | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 |
| Blocky | 106 | 76 | 59 | 96 | 37 | 46 | 78 | 30 | 40 |
| Scalloped faceted | 40 | 96 | 228 | 25 | 45 | 107 | 121 | 79 | 146 |
| Globular | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Maclura type blocky hairbase | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Gobbet - irregular | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Other | 505 | 336 | 333 | 385 | 372 | 424 | 463 | 387 | 313 |
| **TOTAL NON-GRAMINOID** | 653 | 512 | 622 | 511 | 467 | 577 | 663 | 501 | 500 |
| TOTAL PHYTOLITHS COUNTED | 668 | 565 | 636 | 528 | 476 | 614 | 668 | 508 | 515 |

| Depth | 175 | 180 | 185 | 190 | 195 | 205 | 215 | 230 | 235 |
|---|---|---|---|---|---|---|---|---|---|
| cal yr BP | 13670 | 14000 | 14330 | 14640 | 14940 | 15510 | 16040 | 16740 | 16960 |
| POACEAE | | | | | | | | | |
| Diagnostic short cells | 3 | 4 | 5 | 8 | 6 | 14 | 14 | 9 | 33 |
| Other non-diagnostic | 3 | 1 | 2 | 1 | 1 | 7 | 9 | 5 | 21 |
| Total short cells | 6 | 5 | 7 | 9 | 7 | 21 | 23 | 14 | 54 |
| Smooth | 1 | 0 | 0 | 3 | 1 | 3 | 3 | 4 | 3 |
| Sinuous | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Serrated | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 |
| Echinate | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 |
| Dendritic | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Total elongates | 2 | 0 | 0 | 3 | 1 | 8 | 3 | 4 | 5 |
| Long point | 0 | 1 | 0 | 0 | 1 | 2 | 0 | 2 | 3 |
| Short pointy | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| Total pointy | 0 | 1 | 1 | 0 | 1 | 3 | 0 | 3 | 3 |
| Fan-bamboo | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Fan-reed | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Fan | 5 | 2 | 0 | 0 | 0 | 7 | 1 | 1 | 4 |
| Fan/Keystone shaped | 5 | 2 | 0 | 0 | 0 | 7 | 1 | 1 | 4 |
| Square | 1 | 0 | 0 | 1 | 1 | 2 | 2 | 1 | 5 |
| Rectangular | 0 | 0 | 3 | 0 | 1 | 2 | 4 | 6 | 2 |
| Broad elongate | 0 | 0 | 1 | 0 | 0 | 5 | 0 | 1 | 10 |
| Total parallelepipedal | 1 | 0 | 4 | 1 | 2 | 9 | 6 | 8 | 17 |
| Total Bulliforms | 6 | 2 | 4 | 1 | 2 | 16 | 7 | 9 | 21 |
| Undetermined | 2 | 1 | 6 | 2 | 0 | 5 | 3 | 5 | 15 |
| TOTAL GRASS | 16 | 9 | 18 | 15 | 11 | 53 | 36 | 35 | 98 |
| CYPERACEAE | | | | | | | | | |
| Cyperaceae Achenes | 1 | 0 | 0 | 1 | 6 | 1 | 0 | 8 | 1 |
| Cyperaceae-type papillae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL CYPERACEAE | 1 | 0 | 0 | 1 | 6 | 1 | 0 | 8 | 1 |
| **TOTAL GRAMINOID** | 17 | 9 | 18 | 16 | 17 | 54 | 36 | 43 | 99 |
| | | | | | | | | | |
| NON-GRAMINOID | | | | | | | | | |
| Asteraceae platelets | 16 | 5 | 0 | 2 | 2 | 0 | 1 | 0 | 0 |
| Celtis type | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Blocky | 26 | 56 | 117 | 67 | 80 | 38 | 134 | 85 | 54 |
| Scalloped faceted | 9 | 118 | 25 | 36 | 14 | 33 | 11 | 41 | 7 |
| Globular | 0 | 1 | 0 | 0 | 0 | 0 | | 1 | |
| Maclura type blocky hairbase | 0 | 0 | 0 | 0 | 1 | 0 | | | |
| Gobbet - irregular | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Other | 484 | 305 | 326 | 336 | 458 | 391 | 415 | 409 | 358 |
| **TOTAL NON-GRAMINOID** | 537 | 485 | 468 | 442 | 555 | 462 | 562 | 536 | 419 |
| TOTAL PHYTOLITHS COUNTED | 553 | 494 | 486 | 457 | 566 | 515 | 598 | 571 | 517 |

| | | | |
|---|---|---|---|
| Depth | 240 | 245 | 250 |
| cal yr BP | 17160 | 17360 | 17550 |
| POACEAE | | | |
| Diagnostic short cells | 53 | 57 | 66 |
| Other non-diagnostic | 38 | 35 | 1 |
| Total short cells | 91 | 92 | 67 |
| Smooth | 3 | 4 | 3 |
| Sinuous | 0 | 0 | 0 |
| Serrated | 3 | 3 | 0 |
| Echinate | 0 | 0 | 0 |
| Dendritic | 0 | 0 | 1 |
| Total elongates | 6 | 7 | 4 |
| Long point | 4 | 4 | 9 |
| Short pointy | 1 | 3 | 2 |
| Total pointy | 5 | 7 | 11 |
| Fan-bamboo | 0 | 0 | 0 |
| Fan-reed | 0 | 0 | 0 |
| Fan | 5 | 4 | 4 |
| Fan/Keystone shaped | 5 | 4 | 4 |
| Square | 4 | 5 | 4 |
| Rectangular | 1 | 4 | 7 |
| Broad elongate | 5 | 5 | 0 |
| Total parallelepipedal | 10 | 14 | 11 |
| Total Bulliforms | 15 | 18 | 15 |
| Undetermined | 9 | 5 | 12 |
| TOTAL GRASS | 126 | 129 | 109 |
| CYPERACEAE | | | |
| Cyperaceae Achenes | 0 | 4 | 0 |
| Cyperaceae-type papillae | 0 | 0 | 3 |
| TOTAL CYPERACEAE | 0 | 4 | 3 |
| **TOTAL GRAMINOID** | 126 | 133 | 658 |
| | | | |
| NON-GRAMINOID | | | |
| Asteraceae platelets | 0 | 2 | 3 |
| Celtis type | 0 | 0 | 1 |
| Blocky | 29 | 55 | 111 |
| Scalloped faceted | 166 | 14 | 4 |
| Globular | | | 0 |
| Maclura type blocky hairbase | | | 0 |
| Gobbet - irregular | 0 | 0 | 0 |
| Other | 408 | 366 | 203 |
| **TOTAL NON-GRAMINOID** | 603 | 437 | 451 |
| TOTAL PHYTOLITHS COUNTED | 729 | 566 | 560 |

**Table S10 Diagnostic grass silica short cells (GSSC) and ratios.**

| Depth | -5 | 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 |
|---|---|---|---|---|---|---|---|---|---|
| Cal yr BP | 0 | 730 | 920 | 1140 | 1380 | 1640 | 1930 | 2230 | 2560 |
| Pooid | | | | | | | | | |
| Keeled | 4 | 2 | 1 | 0 | 4 | 2 | 1 | 1 | 0 |
| Conical | 3 | 3 | 3 | 1 | 1 | 4 | 0 | 3 | 1 |
| Pyramidal | 2 | 1 | 3 | 2 | 2 | 3 | 1 | 0 | 2 |
| Round and trapezoidal | 1 | 1 | 2 | 0 | 2 | 2 | 1 | 3 | 0 |
| Long wavy trapezoid | 1 | 1 | 1 | 2 | 2 | 5 | 0 | 3 | 0 |
| Stipa-type | 3 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| Long straight trapezoidal | 1 | 0 | 3 | 5 | 2 | 3 | 0 | 1 | 1 |
| Panicoid | | | | | | | | | |
| Panicoid bilobates | 22 | 9 | 7 | 5 | 3 | 7 | 3 | 4 | 3 |
| Polylobates | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 |
| Crosses | 11 | 7 | 2 | 1 | 1 | 1 | 1 | 0 | 1 |
| Two-side horned panicoid | 1 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| Chloridoid | | | | | | | | | |
| Short saddles | 40 | 32 | 30 | 30 | 37 | 34 | 11 | 10 | 5 |
| Ellipsoid saddles (Spartina-type) | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| Aristidoid | | | | | | | | | |
| Aristida-type bilobates | 5 | 2 | 3 | 2 | 1 | 1 | 0 | 0 | 0 |
| Pooid | 15 | 8 | 13 | 11 | 13 | 20 | 3 | 11 | 4 |
| Panicoid | 33 | 16 | 9 | 6 | 6 | 9 | 4 | 4 | 4 |
| Chloridoid | 40 | 32 | 30 | 30 | 37 | 34 | 11 | 10 | 5 |
| | | | | | | | | | |
| C3 to C4 | 17.045 | 14.2857 | 25 | 23.4 | 23.214 | 31.746 | 16.6667 | 44 | 30.76923 |
| Panicoid to Chloridod | 45.205 | 33.3333 | 23.077 | 16.67 | 13.953 | 20.93 | 26.6667 | 28.5714 | 44.44444 |

| Depth | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 |
|---|---|---|---|---|---|---|---|---|---|
| Cal yr BP | 2900 | 3250 | 3620 | 4000 | 4400 | 4800 | 5200 | 5620 | 6040 |
| Pooid | | | | | | | | | |
| Keeled | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Conical | 1 | 2 | 0 | 1 | 2 | 0 | 1 | 0 | 1 |
| Pyramidal | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| Round and trapezoidal | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Long wavy trapezoid | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Stipa-type | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Long straight trapezoidal | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Panicoid | | | | | | | | | |
| Panicoid bilobates | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| Polylobates | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Crosses | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Two-side horned panicoid | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Chloridoid | | | | | | | | | |
| Short saddles | 1 | 4 | 2 | 0 | 2 | 0 | 1 | 4 | 3 |
| Ellipsoid saddles (Spartina-type) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Aristidoid | | | | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Aristida-type bilobates | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| Pooid | 2 | 8 | 0 | 3 | 2 | 0 | 1 | 0 | 1 |
| Panicoid | 0 | 2 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| Chloridoid | 1 | 4 | 2 | 0 | 2 | 0 | 1 | 4 | 3 |
| | | | | | | | | | |
| C3 to C4 | 66.667 | 57.1429 | 0 | 75 | 50 | 0 | 50 | 0 | 25 |
| Panicoid to Chloridod | 0 | 33.3333 | 0 | 100 | 0 | 100 | 0 | 20 | 0 |
| | | | | | | | | | |
| Depth | 85 | 90 | 95 | 100 | 105 | 110 | 115 | 120 | 125 |
| Cal yr BP | 6460 | 6890 | 7320 | 7750 | 8170 | 8600 | 9030 | 9450 | 9860 |
| Pooid | | | | | | | | | |
| Keeled | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Conical | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| Pyramidal | 2 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| Round and trapezoidal | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Long wavy trapezoid | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Stipa-type | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Long straight trapezoidal | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Panicoid | | | | | | | | | |
| Panicoid bilobates | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 |
| Polylobates | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Crosses | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| Two-side horned panicoid | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Chloridoid | | | | | | | | | |
| Short saddles | 4 | 2 | 5 | 3 | 0 | 4 | 5 | 2 | 1 |
| Ellipsoid saddles (Spartina-type) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Aristidoid | | | | | | | | | |
| Aristida-type bilobates | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pooid | 3 | 0 | 2 | 0 | 0 | 1 | 1 | 0 | 1 |
| Panicoid | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 2 |
| Chloridoid | 4 | 2 | 5 | 3 | 0 | 4 | 5 | 2 | 1 |
| | | | | | | | | | |
| C3 to C4 | 37.5 | 0 | 25 | 0 | #DIV/0! | 16.667 | 16.6667 | 0 | 25 |
| Panicoid to Chloridod | 20 | 0 | 16.667 | 25 | #DIV/0! | 20 | 0 | 0 | 66.66667 |
| | | | | | | | | | |
| Depth | 130 | 135 | 140 | 145 | 150 | 155 | 160 | 165 | 170 |
| Cal yr BP | 10280 | 10690 | 11090 | 11480 | 11870 | 12250 | 12620 | 12980 | 13330 |
| Pooid | | | | | | | | | |
| Keeled | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| Conical | 0 | 1 | 0 | 2 | 0 | 1 | 1 | 0 | 1 |
| Pyramidal | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| Round and trapezoidal | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Long wavy trapezoid | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Stipa-type | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Long straight trapezoidal | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Panicoid | | | | | | | | | |
| Panicoid bilobates | 0 | 3 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| Polylobates | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Crosses | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Two-side horned panicoid | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Chloridoid | | | | | | | | | |
| Short saddles | 1 | 7 | 1 | 0 | 0 | 1 | 0 | 0 | 1 |
| Ellipsoid saddles (Spartina-type) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Aristidoid | | | | | | | | | |
| Aristida-type bilobates | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Pooid | 0 | 4 | 0 | 3 | 0 | 4 | 1 | 1 | 2 |
| Panicoid | 0 | 3 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| Chloridoid | 1 | 7 | 1 | 0 | 0 | 1 | 0 | 0 | 1 |
| | | | | | | | | | |
| C3 to C4 | 0 | 28.5714 | 0 | 100 | #DIV/0! | 66.667 | 100 | 50 | 50 |
| Panicoid to Chloridod | 0 | 30 | 0 | ##### | #DIV/0! | 50 | #DIV/0! | 100 | 50 |
| | | | | | | | | | |
| Depth | 175 | 180 | 185 | 190 | 195 | 205 | 215 | 230 | 235 |
| Cal yr BP | 13670 | 14000 | 14330 | 14640 | 14940 | 15510 | 16040 | 16740 | 16960 |
| Pooid | | | | | | | | | |
| Keeled | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Conical | 1 | 1 | 0 | 2 | 1 | 1 | 3 | 1 | 3 |
| Pyramidal | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 |
| Round and trapezoidal | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 3 | 2 |
| Long wavy trapezoid | 0 | 1 | 0 | 0 | 0 | 2 | 1 | 1 | 3 |
| Stipa-type | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 1 | 6 |
| Long straight trapezoidal | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Panicoid | | | | | | | | | |
| Panicoid bilobates | 0 | 0 | 0 | 1 | 1 | 3 | 0 | 1 | 3 |
| Polylobates | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Crosses | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 3 |
| Two-side horned panicoid | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Chloridoid | | | | | | | | | |
| Short saddles | 1 | 0 | 0 | 2 | 2 | 3 | 3 | 0 | 4 |
| Ellipsoid saddles (Spartina-type) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Aristidoid | | | | | | | | | |
| Aristida-type bilobates | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 |
| Pooid | 1 | 3 | 2 | 5 | 3 | 4 | 6 | 7 | 16 |
| Panicoid | 0 | 0 | 1 | 1 | 1 | 4 | 0 | 1 | 6 |
| Chloridoid | 1 | 0 | 0 | 2 | 2 | 3 | 3 | 0 | 4 |
| | | | | | | | | | |
| C3 to C4 | 50 | 100 | 66.667 | 62.5 | 50 | 36.364 | 66.6667 | 87.5 | 61.53846 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Panicoid to Chloridod | 0 | 0 | 100 | 33.33 | 33.333 | 57.143 | 0 | 100 | 60 |

| | | | |
|---|---|---|---|
| Depth | 240 | 245 | 250 |
| Cal yr BP | 17160 | 17360 | 17550 |
| Pooid | | | |
| Keeled | 2 | 6 | 8 |
| Conical | 3 | 4 | 2 |
| Pyramidal | 0 | 5 | 2 |
| Round and trapezoidal | 2 | 0 | 1 |
| Long wavy trapezoid | 2 | 5 | 9 |
| Stipa-type | 13 | 7 | 0 |
| Long straight trapezoidal | 2 | 1 | 9 |
| Panicoid | | | |
| Panicoid bilobates | 5 | 4 | 0 |
| Polylobates | 0 | 0 | 3 |
| Crosses | 2 | 0 | 0 |
| Two-side horned panicoid | 3 | 0 | 15 |
| Chloridoid | | | |
| Short saddles | 6 | 9 | 0 |
| Ellipsoid saddles (Spartina-type) | 0 | 0 | 0 |
| Aristidoid | | | |
| Aristida-type bilobates | 0 | 0 | 0 |
| Pooid | 24 | 28 | 31 |
| Panicoid | 7 | 4 | 3 |
| Chloridoid | 6 | 9 | 0 |
| | | | |
| C3 to C4 ratio | 64.865 | 68.2927 | 91.176 |
| Panicoid to Chloridod ratio | 53.846 | 30.7692 | 100 |