APPENDIX B

41RB112 SEDIMENT SAMPLE PHYTOLITH ANALYSIS

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B.1 Phytoliths

Phytoliths, inorganic siliceous residues that form in plant cells, frequently mirror parent cell shape. Phytoliths become a mineral particle in soil when plants decay. Thus, to the extent that plant cell architecture is unique to a given species, phytolith morphology provides a mechanism whereby the plant origin of the phytolith can potentially be determined. For most grasses (Poaceae), the subfamily that produced a short cell phytolith is readily discernible from the phytolith's morphology. Many other botanical species also produce phytoliths; information about their morphology is gradually being gleaned from studies of new reference specimens. A more detailed overview was recently released (Sudbury 2011a:2-14).

Phytoliths are persistent in the soil, often surviving for tens of thousand of years, and provide evidence of past landscape and environmental conditions. Phytoliths may even enter the geological record and have been recovered in fossils. All silica is soluble—even quartz—but at a very low solubility rate; in cases where soil pH is high (basic), the rate of phytolith dissolution is enhanced which affect phytolith's survival. In addition to being soluble under certain conditions, phytoliths are also mobile as are all soil components. Thus, when exposed on the soil surface, phytoliths are prone to movement and redeposition, whether by erosive runoff during rain events, by flooding or redeposition by wind erosion. Another movement mechanism is when phytoliths are intentionally moved—such as by harvesting a crop; phytoliths also be relocated when they are deposited in animal droppings.

B.2 Sample Processing

Twenty-four sediment samples and one control surface soil sample from the Late Prehistoric Long View site (41RB112) were received for phytolith analysis (Table B-1). Due to the relatively small sample size (~30 g), the samples were transferred directly to the sample processing containers without preliminary sieving. The samples were oven dried, cooled, and weighed. Next, the samples were then vigorously agitated in 5 percent Calgon solution for 24 hours to disaggregate the clays. After the appropriate settling time, the combined silt and clay fractions were repeatedly decanted from the sand fraction (2.65 g/cm^3, > 50 microns) until only the sand fraction remained (Figure B-1 shows the sample suspensions at the beginning of the decanting procedure). As a result of this separation procedure, lower density sand-size particles (i.e., including large phytoliths) tend to be included in the decanted silt/clay fraction. Once the silt/clay fractions (which contain the phytoliths) were completely decanted, the clean sands were oven dried and weighed (Table B-2).

Next, the combined silt-clay components were re-suspended and the silt fraction allowed to settle for a time calculated based on a 2 micron particle size and 1.60 g/cm^3 density. Once the settling interval was completed, the suspended clay fractions were removed by siphoning off the upper portion of the solution (Figure B-2). This procedure (suspending in water, settling the silt particles, and removing the suspended clay) was repeated until all of clay was removed leaving behind the silt fraction (i.e., after the settling interval, the liquid phase above the silt was clear indicating clay removal was complete).

Next, the silt fractions were quantitatively transferred to crucibles (Figure B-3) and ashed in a muffle furnace at 530°C to remove the organic material (Sudbury 2011b:44). Carbonates were removed from the ashed silt fractions by adding 10 percent hydrochloric acid (Ibid. 46-47). Once effervescence ceased, the silts were quantitatively transferred to preweighed 50 ml centrifuge tubes, repeatedly rinsed with water, centrifuged, and the aqueous phase removed until the acid had been diluted and eliminated. The isolated silt fractions were oven dried and weighed. With the sand and silt fraction weights, the soil sample texture can be determined (Table B-2).

Heavy aqueous zinc bromide solution (2.35 g/cm^3) was added to the dry silts which were then frequently agitated; after disaggregating, the samples were centrifuged resulting in the biogenic silica fraction (including phytoliths) floating away from the heavier matrix on top of the zinc bromide solution (ibid. 255). The phytoliths were decanted to clean tubes, and the remaining original silt residue repeatedly remixed with fresh zinc bromide solution, centrifuged, and the phytoliths harvested until no

Table B-1. 41RB112 Sediment Samples.

Sample Number	Component	Unit	Depth (cmbs)	Sample Label	Feature Number	Weight (g)	Class
MQ11-1	A	Cutbank	57-61	1278-4-1a	1	30.8	sediment
MQ11-2	A	N700 E515	56-59	1164-4-11a	1	31	sediment
MQ11-3	A	N700 E515	56-59	1164-4-7a	1	31	sediment
MQ11-4	A	N699 E512	30-40	1116-4-1a	8 W 1/2	30.1	sediment
MQ11-5	A	N698 E511	31-53	1080-4-1a	10	30.8	sediment
MQ11-6	A	N696 E511	50-60	1032-4-1c	11	31.1	sediment
MQ11-7	A	N695 E513/514	59-61	1014-4-5b	13	30.4	sediment
MQ11-8	A	N699 E514	20-30	1128-4-1a	-	30.8	sediment
MQ11-9	B	B-1	92-96	77-4-1a	-	31.5	sediment
MQ11-10	C	Cutbank	32-36	120-4-4a	5	30.2	sediment
MQ11-11	C	N500 E 497	71-73	1284-4-1a	6	30.7	sediment
MQ11-12	C	N500 E 497	66-68	1282-4-1a	6	31.1	sediment
MQ11-13	C	C-7	60-64	139-4-1a	6	30.7	sediment
MQ11-14	C	Col-3 Z 3	25-30	C-3 Zone 3 Spl 6	6	38	sample 6
MQ11-15	C	Col-3 Z 4	65-70	C-3 Zone 4 Spl 14	6	32	sample 14
MQ11-16	C	Col-3 Z 5	78-83	C-3 Zone 5 Spl 17	6	32	sample 17
MQ11-17	C	Col-3 Z 5	83-87	C-3 Zone 5 Spl 18	6	36	sample 18
MQ11-18	C	Col-7 Z 7	33-38	C-7 Zone 7 Spl 8	6	31	sample 8
MQ11-19	C	Col-7 Z 9	38-44	C-7 Zone 9 Spl 9	6	32	sample 9
MQ11-20	C	Col-7 Z 5	44-51	C-7 Zone 5 Spl 10	6	35	sample 10
MQ11-21	C	N492 E501	50-59	472-4-1a	16	30.8	sediment
MQ11-22	C	N480 E500	40-50	234-4-1a	20	30.3	sediment
MQ11-23	C	N482 E501	87-90	331-004-2b	23	31.6	sediment
MQ11-24	C	N499 E497	40-48	644-4-1a	24	30.1	sediment
MQ11-25	NA	Surface	2-4	1281-4a	Control	37	sediment

Figure B-1. Silt/clay removal.

Sediment samples in water in the original mixing containers (250 ml glass jars with Teflon®-lined lids, front row). After the sand fractions settle, the suspended silt and clay fractions (front row) are decanted away from the sand into the two-liter settling containers (back row).

Figure B-2. Clay removal.

After allowing the silt fraction (> 2 microns, < 1.60 g/cm^3) from the back row of bottles in Figure B-1 to settle for three days, the upper solution containing the suspended clay fraction (< 2 microns) was siphoned off of the silt fraction sediment and stored in another 2-liter bottle. Re-suspension and settling of the mixture in the original 2-liter bottle was repeated until the smaller particle size clay fraction was removed from the silt fraction. The silt was next processed further to recover the soil phytoliths. After additional settling, the isolated clay fractions for each sample are dried and retained.

more phytoliths were recovered. Then the pooled phytoliths were centrifuged to remove any residual clay carried over in the decants; once the phytoliths were demonstrated to be clay-free they were transferred to a clean centrifuge tube and water was added to the phytolith solution to lower the solution density to < 1.50g/cm^3 causing the phytoliths to sink and form a pellet when centrifuged. The phytolith pellet was washed repeatedly until the zinc bromide had been removed (the copious aqueous rinses were filtered and concentrated to recover the zinc bromide for reuse). The phytoliths were then transferred to pre-weighed and prelabeled 4 dram vials, dried, and the phytolith recovery determined. The phytolith soil concentrations (weight % in soil) are reported in Table B-2. The soils' high sand concentration resulted in the phytolith concentrations (i.e., a component of the silt fraction of soil) being relatively low.

Next, a portion of the dried phytolith fraction was mounted on microscope slides using Canada balsam and allowed to cure prior to examination (Sudbury 2011b:50-51). The specimen slides were scanned via microscopy at 500x and the short cell phytoliths in the fields of view tabulated by their morphology (Tables B3 through 6). The slides were then rescanned taking photographs of additional specimens of interest that were not observed during the formal particle count scans.

B.3 Data

B.3.1 Sand Fraction

Figures B-4 through B-6 show pictures of the dried sand fractions after silt and clay removal (isolated during the procedure shown in Figure B-1). These images enable comparison of the amount of organic debris present in the sand fractions (charcoal, roots, and other organic matter). Looking at the full size images also provides an idea of other detail such as sand grain size variation; for instance, the larger image presented for sample 25 shows that the sand grain size in the surface control sample is poorly sorted (Figure B-4). The color difference between sand samples is real and may reflect difference in burial conditions (Sudbury 2011b:148-149) or the source of parent material. The charcoal which floated to the surface before drying may also impact observed shading or coloration.

Prior to transferring the clean sands to storage containers, they were placed in a Petri dish and examined via stereo-microscopy. Charcoal fragments were common, and bone and burned bone fragments were noted in some samples. The most noteworthy observations included part of a maize kernel (Figure B-7), a small jaw fragment with a multi-rowed set of teeth (probably reptilian (Figure B-8), and several snail shells and shell fragments (Figures B-9 though B-10).

Figure B-3. Crucibles containing silt fractions ready for ashing in the muffle furnace to remove organic materials.

Table B-2. 41RB112 Sediment Sample Textures.

Sample Number	Excavation Unit	Oven-dried Soil Wt (g)	Sand %	Silt %	Soil Texture	Phytoliths Wt % Soil
MQ11-1	Cutbank	30.42	66.90%	16.20%	Sandy Loam	0.08%
MQ11-2	N700 E515	30.62	70.60%	14.80%	Sandy Loam	0.14%
MQ11-3	N700 E515	30.82	75.10%	11.50%	Sandy Loam	0.07%
MQ11-4	N699 E512	29.8	69.30%	16.20%	Sandy Loam	0.09%
MQ11-5	N698 E511	30.13	66.40%	17.80%	Sandy Loam	0.11%
MQ11-6	N696 E511	30.47	60.80%	20.40%	Sandy Clay Loam	0.12%
MQ11-7	N695 E513/514	29.65	58.10%	22.80%	Sandy Clay Loam	0.09%
MQ11-8	N699 E514	30.46	74.30%	17.40%	Sandy Loam	0.16%
MQ11-9	B-1	30.87	48.50%	33.50%	Loam	0.10%
MQ11-10	Cutbank	29.43	62.50%	18.70%	Sandy Clay Loam	0.35%
MQ11-11	N500 E 497	30.16	72.00%	11.10%	Sandy Loam	0.08%
MQ11-12	N500 E 497	30.41	69.20%	10.30%	Sandy Clay Loam	0.05%
MQ11-13	C-7	29.93	50.50%	18.90%	Sandy Clay Loam	0.05%
MQ11-14	Col -3 Zone 3	35.33[1]	80.60%	15.80%	Loamy Sand	0.24%
MQ11-15	Col -3 Zone 4	29.83	65.80%	11.90%	Sandy Clay Loam	0.06%
MQ11-16	Col -3 Zone 5	30.11	58.40%	16.60%	Sandy Clay Loam	0.04%
MQ11-17	Col -3 Zone 5	34.19	59.50%	16.80%	Sandy Clay Loam	0.11%
MQ11-18	Col -3 Zone 7	29.5	74.60%	9.40%	Sandy Loam	0.13%
MQ11-19	Col -3 Zone 9	30.07	71.00%	10.60%	Sandy Loam	0.08%
MQ11-20	Col -3 Zone 5	33.73	69.30%	12.40%	Sandy Loam	0.07%
MQ11-21	N492 E501	30.02	68.70%	12.90%	Sandy Loam	0.07%
MQ11-22	N480 E500	29.89	81.10%	8.30%	Loamy Sand	0.08%
MQ11-23	N482 E501	28.95	73.50%	10.30%	Sandy Loam	0.05%
MQ11-24	N499 E497	29.41	71.90%	9.80%	Sandy Loam	0.12%
MQ11-25	Surface Control	33.22	80.20%	12.90%	Loamy Sand	0.22%

[1] One piece of sandstone gravel (1.11 grams) was removed from sample MQ11-14 after extraction, and the original dried sample weight corrected for the gravel removal.

Figure B-4. Clean dried sand fraction of surface control soil sample 25 (control sample from pristine prairie on south side of Canadian River).

B.3.2 Silt Fraction-Phytoliths.

The observed phytolith morphology counts are in Tables B-3 through B-6. The first twelve phytolith types—all of the short cell phytolith morphotypes—are representative of the three basic "seasonality" types of Poaceae (grasses). Seasonality is a simplified way of summarizing the optimal growth conditions under which certain plants thrive; these differences are based on the cellular architecture of the plant which are due in part to differences in the metabolic machinery of the plants. Thus, plants that grow well in a cool moist environment (the Pooidaceae subfamily of grasses, later referred to herein as "pooids") do not thrive in a hot or dry environment as they are basically unable to conserve their internal moisture during in hot weather conditions. These plants grow well in northern climates, but do occur locally in shaded or moist environments—including in riparian settings. In general, the pooids are the plants that show the first green in the spring and the last green in the fall—they do well in the cooler weather. The other two subfamilies contributing short cell phytoliths to the soil record are the chloridoid subfamily (Chloridoideae), which thrive in hot dry environments, and the panicoid subfamily (Panicoideae) which do well in hot environments but have a somewhat greater moisture requirement than the chloridoids. The chloridoids are the major component of the shortgrass prairies while the panicoids are the major species present in the tallgrass prairies; mixedgrass prairies are a blend of the two prairie types in the zone where they intersect and overlap. The pooids are present in their niche in all three prairie zones—normally in relatively low concentration (depending on the environmental setting).

The short cell morphotype counts for these samples are in Tables B-3 through B-6; the raw counts are the top twelve phytolith forms listed. The three seasonality groupings (described above) of these twelve forms are summed and normalized in the lower section of each table. The short cell morphology reflects the plant's cellular architecture and thus the short cell morphotypes can be assigned to (and are representative of) a specific seasonal Poaceae subfamily. The tables are also color-coded for ease of navigation (chloridoids (C_4, hot and dry) are red, pooids (C_3, cool and moist) are blue, and the C_4 panicoids are green (C_3 and C_4 refer to the specific metabolic cycle which the plants employ). The rest of the phytolith forms listed in the tables are not short cells, but are other morphotypes which were observed in the same microscopic fields of view during the counting procedure. Bulliform phytoliths, sometimes called motor cells, occur most frequently in C_4 plants and enable the plants to curl their leaves in the hot weather in order to conserve plant moisture. Noting the relatively high bulliform phytolith counts in some samples, the total bulliform to short cell phytolith ratios also calculated and are located at the bottom of the tables. The ratios of charcoal fragments to bulliform phytoliths and to

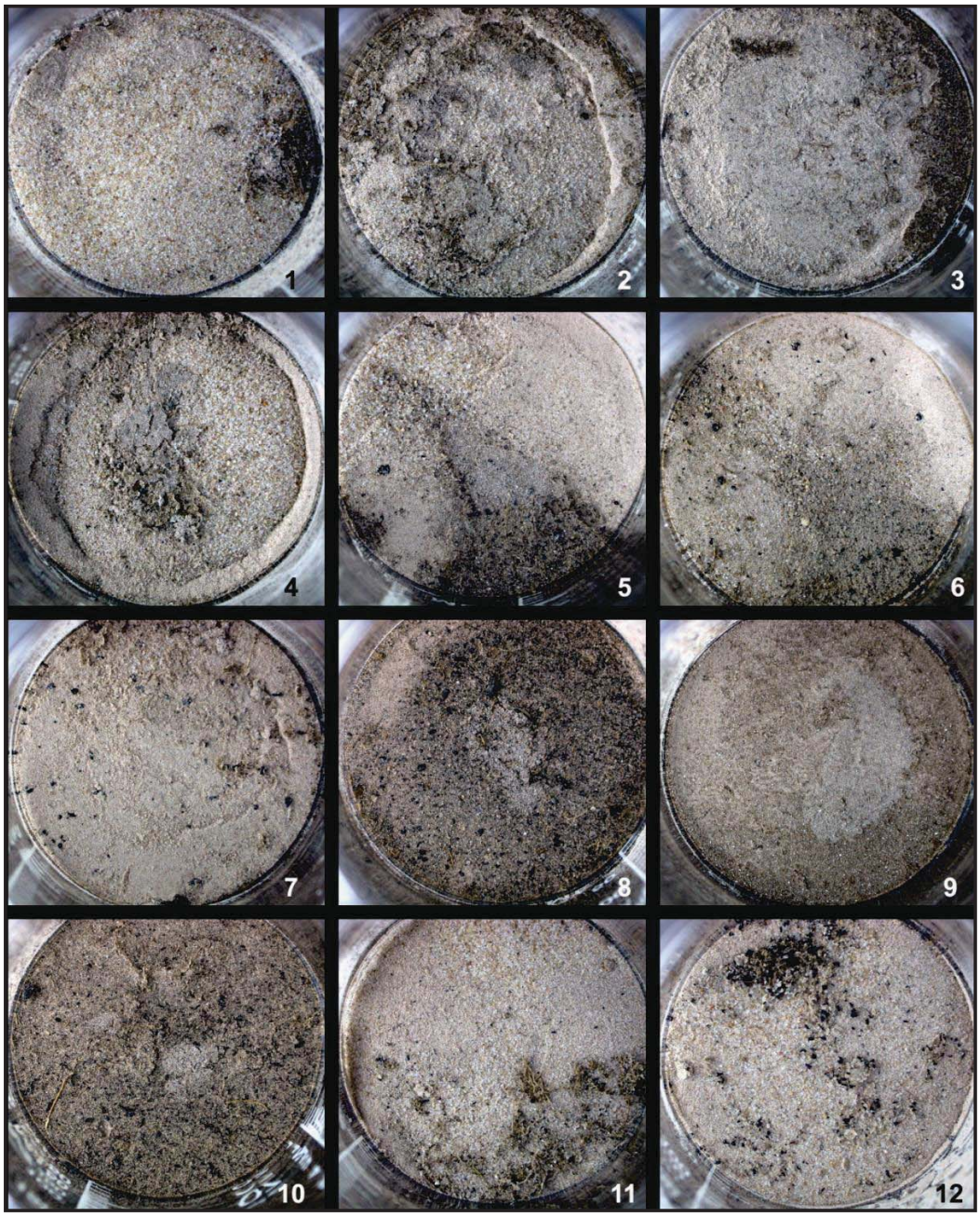

Figure B-5. Dry sand fractions of samples 1 through 12.

Sample 1 (from cutbank profile, base of pithouse 1), sample 2 (from profile wall, floor of pithouse 1), sample 3 (from floor of pithouse 1), sample 4 (inside west half of small basin heating element), sample 5 (southwest part of broad heating element, Feature 10), sample 6 (inside heating element, Feature 11), sample 7 (bottom of small storage pit, Feature 13), sample 8 (ashy stain next to heating element Feature 10), sample 9 (lower part of thickened A horizon, in shallow swale between Components A and C), sample 10 (bottom of basin heating element Feature 5), sample 11 (pithouse 2 floor, Feature 6), and sample 12 (lower portion of construction fill on top of floor, Feature 6).

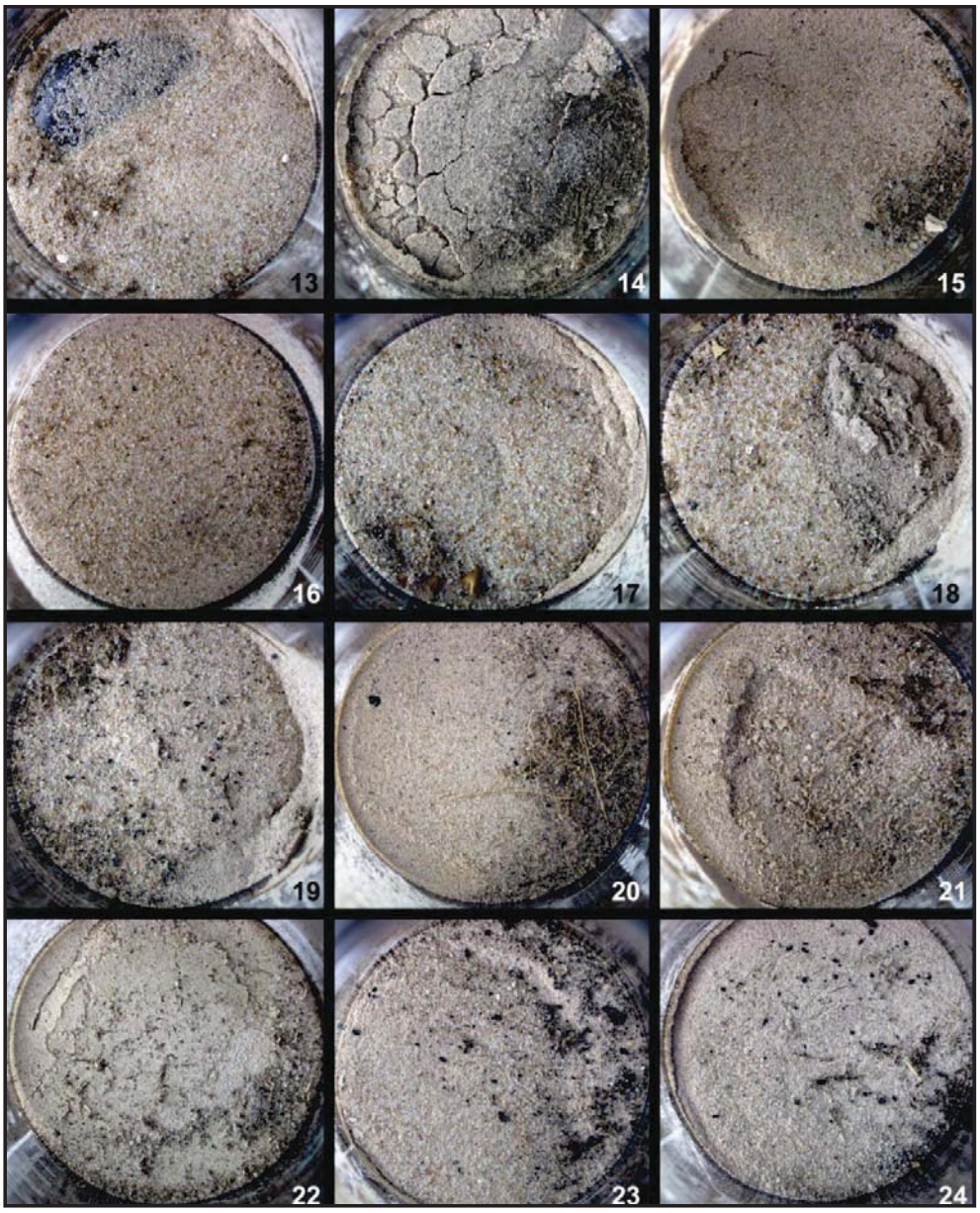

Figure B-6. Dry sand fractions of samples 13 through 24.

Sample 13 (north wall profile inside and on floor of pithouse 2, Feature 6), sample 14 (upper end of eolian fill on top of construction fill towards western side of pithouse 2, Feature 6), sample 15 (middle of earthen construction fill inside pithouse 2, western side, Feature 6), sample 16 (upper part of pithouse 2 floor below earthen construction fill, western side, Feature 6), sample 17 (bottom of pithouse 2 floor, western side), sample 18 (earthen construction fill near center of pithouse 2, Feature 6), sample 19 (pithouse floor, upper, near center of pithouse 2, Feature 6), sample 20 (pithouse floor near center of pithouse 2, Feature 6), sample 21 (bottom of basin heating element with burned maize cobs, Feature 16), sample 22 (bottom of heating element with burned maize cobs, Feature 20), sample 23 (inside, bottom of storage pit, Feature 23), and sample 24 (ashy stain on floor of pithouse 2, Feature 6 eastern end).

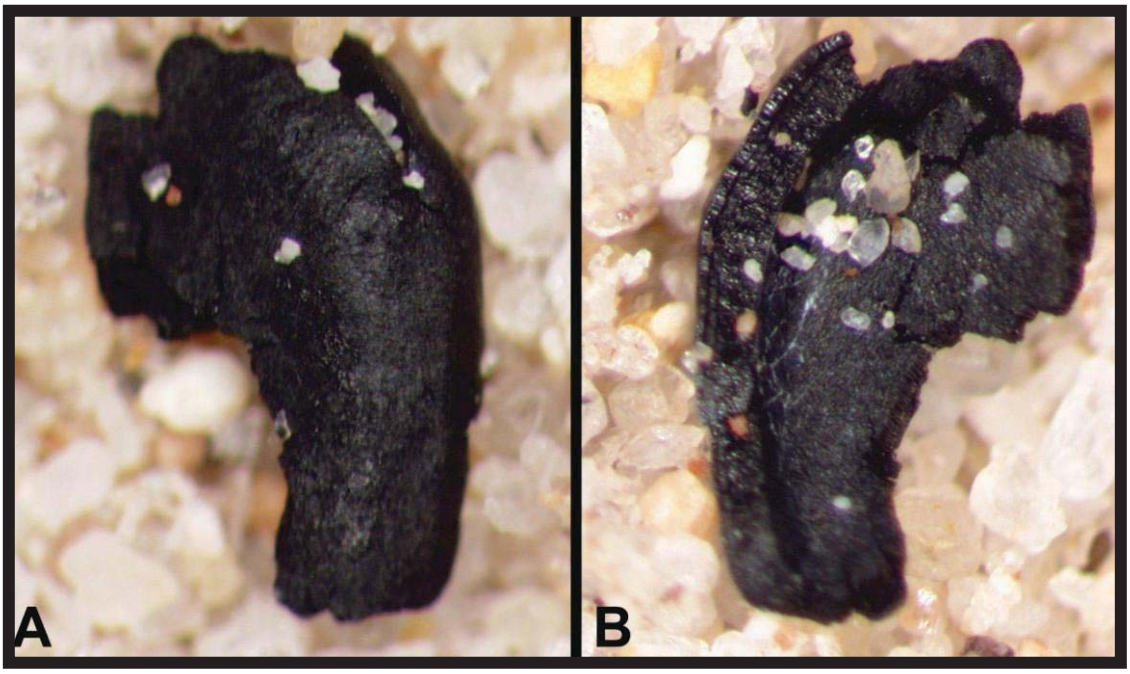

Figure B-7. Two views of a charred maize kernel fragment present in the sand fraction from the floor of pithouse 1 (a-external surface, b- internal surface; recovered from sample 3).

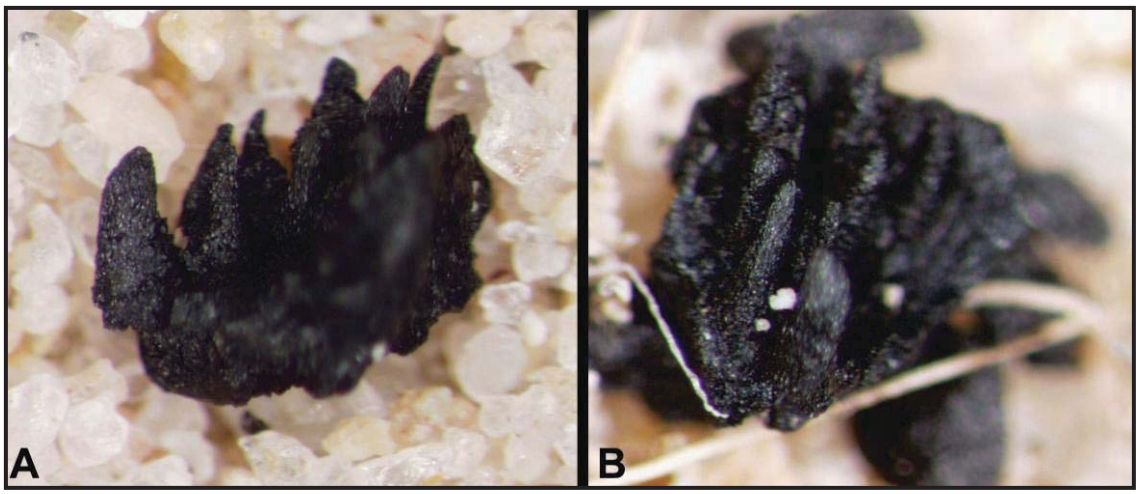

Figure B-8. Snail shells and shell fragments from 41RB112.

A and B: two views of specimen from the profile wall of the floor of pithouse 1 (sample 2). C: specimen from the floor of pithouse 1 (sample 3). D and H shell fragments from the lower part of the thickened A horizon between pithouses 1 and 2 (sample 9). The 2 mm scale bar applies to all snail specimens.

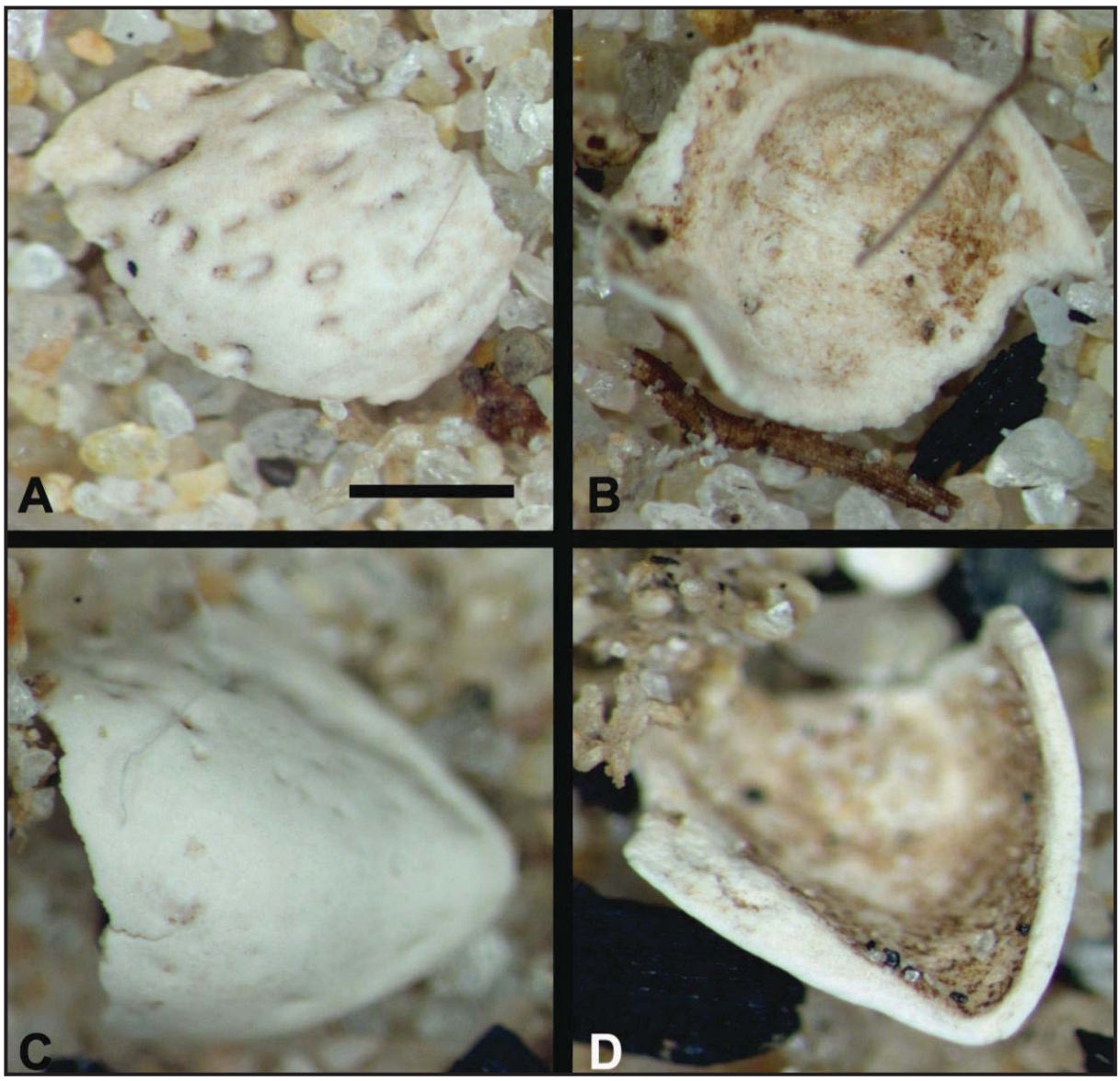

Figure B-9. Two snail shell fragments (41RB112).
Shell fragments from the lower portion of the construction fill above the floor of pithouse 2, Feature 6 (sample 12). The 2 mm scale bar applies to all specimens.

Table B-3. Soil Sample Phytolith Counts, Samples 1 Through 6 (41RB112).

	Soil 1	Soil 2	Soil 3	Soil 4	Soil 5	Soil 6
Phytolith Morphology						
Keeled	20	17	12	16	26	28
Conical	22	26	25	21	43	57
Pyramidal	14	18	19	15	12	21
Crenate	10	7	8	4	6	6
Saddle, squat	32	32	34	29	34	22
Saddle, tall	82	90	102	50	45	56
Stipa	5	-	-	2	5	1
Lobate, Simple	4.5	3.5	1	2	1	2
Lobate, Panicoid	20	30	17	17.5	56	38.5
Lobate, Pan'd (compound)	-	-	-	-	-	1
Cross, Panicoid (<12 um)	2	1	3	1	2	1
Cross, Panicoid (>12 um)	6	4	1	1	7	2
Maize Rondel	1	-	-	-	-	1
Dicot, knobby	1	1	-	3	-	1
Spiny spheroid	6	2	5	7	3	3
WWW, Schlerid	2	-	-	3	3	4
Diatom	-	1	-	1	1	2
Sponge spicule	2	-	-	1	-	3
Trichome, Hair Cells	31	14	3	5	18	12
Bulliform, square	38	30	40	37	58	41
Bulliform, rectangular	125	74	45	44	98	86
Bulliform, keystone	43	13	18	48	28	34
Bulliform, Y-shaped	10	8	7	8	6	19
Bulliform, other	180	100	205	171	99	164
Elongate, smooth	7	10	11	5	13	8
Elongate, sinuous	8	9	7	9	4	26
Elongate, castillate	10	7	9	6	5	7
Elongate, spiny	-	-	-	-	-	-
Other Misc. Forms	-	-	-	-	-	-
Charcoal	63	18	39	48	51	84
Possible Pinaceae tracheid elements ?	-	-	-	-	-	-
Sedges	2	3	3	5	6	7
Saddle Imposters	5	6	13	1	7	3
Large Discs	9	3	5	5	11	14
Spore	-	1	-	3	-	-

Table B-3. Soil Sample Phytolith Counts, Samples 1 Through 6 (41RB112) (cont.)

	Soil 1	Soil 2	Soil 3	Soil 4	Soil 5	Soil 6
Phytolith Morphology						
Total Short Cell Counts:	218.5	228.5	222	158.5	237	236.5
Pooids (cool season)	66	68	64	56	87	112
Chloridoids (hot dry)	114	122	136	79	79	78
Panicoids (warm moist)	38.5	38.5	22	23.5	71	46.5
Normalized Short Cells (%)						
Pooids	30.2	29.8	28.8	35.3	36.7	47.3
Chloridoids	52.2	53.4	61.3	49.8	33.3	33
Panicoids	17.6	16.8	9.9	14.8	30	19.7
Total Bulliforms	396	225	315	308	289	344
Ratio Bulliform:Short Cells	1.81	0.98	1.42	1.94	1.22	1.45
Ratio Charcoal:Bulliform	0.16	0.08	0.12	0.16	0.18	0.24
Ratio Charcoal:Short Cells	0.29	0.08	0.18	0.3	0.22	0.36

Table B-4. Soil Sample Phytolith Counts, Samples 7 Through 12 (41RB112)

	Soil 7	Soil 8	Soil 9	Soil 10	Soil 11	Soil 12
Phytolith Morphology						
Keeled	2	14	1	22	26	18
Conical	10	23	6	66	34	29
Pyramidal	4	15	4	5	15	20
Crenate	1	3	-	3	14	8
Saddle, squat	4	44	6	21	24	22
Saddle, tall	6	67	13	30	60	9
Stipa	-	5	-	18	4.5	9
Lobate, Simple	0.5	3.5	1.5	9	5	4
Lobate, Panicoid	7.5	27	1	62	16.5	27
Lobate, Pan'd (compound)	-	1	-	-	-	-
Cross, Panicoid (<12 um)	-	3	-	31	4	6
Cross, Panicoid (>12 um)	-	1	-	16.5	2	3
Maize Rondel	-	-	-	-	-	-
Dicot, knobby	-	-	-	-	-	-
Spiny spheroid	1	2	-	-	2	6
WWW, Schlerid	-	-	-	-	5	1
Diatom	-	1	-	-	-	-

Table B-4. Soil Sample Phytolith Counts, Samples 7 Through 12 (41RB112) (cont.)

	Soil 7	Soil 8	Soil 9	Soil 10	Soil 11	Soil 12
Phytolith Morphology						
Sponge spicule	2	1	1	-	-	-
Trichome, Hair Cells	5	11	6	3	14	28
Bulliform, square	17	38	70	7	34	58
Bulliform, rectangular	52	103	94	4	80	178
Bulliform, keystone	31	48	45	-	26	47
Bulliform, Y-shaped	7	5	2	23	6	6
Bulliform, other	120	188	334	4	161	320
Elongate, smooth	1	4	2	6	9	20
Elongate, sinuous	1	7	2	4	10	24
Elongate, castillate	1	5	2	2	8	16
Elongate, spiny	-	-	-	-	-	1
Other Misc. Forms	-	-	-	-	-	-
Charcoal	67	57	40	10	66	74
Possible Pinaceae tracheid elements ?	-	-	-	-	-	-
Sedges	3	6	5	8	6	1
Saddle Imposters	-	9	-	1	13	5
Large Discs	4	15	-	16	5	1
Spore	1	1	-	-	-	-
Total Short Cell Counts:	35	206.5	32.5	283.5	205	195
Pooids (cool season)	17	55	11	96	89	75
Chloridoids (hot dry)	10	111	19	51	84	71
Panicoids (warm moist)	8	40.5	2.5	136.5	32	49
Normalized Short Cells (%)						
Pooids	48.5	26.6	33.8	33.9	43.4	38.5
Chloridoids	28.6	53.8	58.5	18	41	36.4
Panicoids	22.9	19.6	7.7	48.1	15.6	25.1
Total Bulliforms	227	386	545	38	307	609
Ratio Bulliform:Short Cells	6.49	1.85	16.77	0.13	1.5	3.12
Ratio Charcoal:Bulliform	0.3	0.15	0.07	0.26	0.21	0.12
Ratio Charcoal:Short Cells	1.91	0.28	1.23	0.04	0.32	0.38

Table B-5. Soil Sample Phytolith Counts, Samples 13 Through 18 (41RB112).

	Soil 13	Soil 14	Soil 15	Soil 16	Soil 17	Soil 18
Phytolith Morphology						
Keeled	2	34	10	-	2	21
Conical	6	90	10	4	3	25
Pyramidal	-	24	5	4	6	1
Crenate	-	3	3	-	1	9
Saddle, squat	5	70	5	3	2	23
Saddle, tall	4	101	8	5	3	32
Stipa	1	13	5	1	-	4.5
Lobate, Simple	1	-	4	-	-	3.5
Lobate, Panicoid	-	3	27.5	5	-	74.5
Lobate, Pan'd (compound)	-	--	2	-	-	2
Cross, Panicoid (<12 um)	1	1	-	-	-	7
Cross, Panicoid (>12 um)	-	0.5	3	-	-	14
Maize Rondel	-	-	-	-	-	-
Dicot, knobby	-	-	-	-	-	2
Spiny spheroid	2	1	7	7	5	6
WWW, Schlerid	-	2	-	-	-	1
Diatom	-	1	3	-	-	2
Sponge spicule	1	-	6	2	-	2
Trichome, Hair Cells	1	11	30	4	4	8
Bulliform, square	12	30	46	11	13	16
Bulliform, rectangular	28	54	127	61	39	50
Bulliform, keystone	16	21	58	32	29	9
Bulliform, Y-shaped	1	1	-	5	-	26
Bulliform, other	80	114	409	194	163	61
Elongate, smooth	1	4	5	1	1	2
Elongate, sinuous	10	1	12	4	4	8
Elongate, castellate	3	6	7	6	8	3
Elongate, spiny	-	-	-	-	-	3
Other Misc. Forms	-	-	-	-	-	-
Charcoal	72	15	122	77	75	27
Possible Pinaceae tracheid elements ?	-	1	-	-	-	16
Sedges	1	-	-	-	-	-
Saddle Imposters	1	4	1	2	1	-
Large Discs	-	1	1	2	-	-
Spore	-	1	-	-	-	-

Table B-5. Soil Sample Phytolith Counts, Samples 13 Through 18 (41RB112) (cont.)

	Soil 13	Soil 14	Soil 15	Soil 16	Soil 17	Soil 18
Phytolith Morphology						
Total Short Cell Counts:	20	339.5	82.5	22	17	230.5
Pooids (cool season)	8	151	28	8	12	70
Chloridoids (hot dry)	9	171	13	8	5	55
Panicoids (warm moist)	3	17.5	41.5	6	0	105.5
Normalized Short Cells (%)						
Pooids	40	44.4	33.9	36.3	70.6	30.3
Chloridoids	45	50.4	15.8	36.4	29.4	23.9
Panicoids	15	5.2	50.3	27.3	0	45.8
Total Bulliforms	137	220	640	303	244	162
Ratio Bulliform:Short Cells	6.85	0.65	7.76	13.77	14.35	0.7
Ratio Charcoal:Bulliform	0.53	0.07	0.19	0.25	0.31	0.17
Ratio Charcoal:Short Cells	3.6	0.04	1.48	3.5	4.41	0.12

Table B-6. Soil Sample Phytolith Counts, Samples 19 Through 25 (41RB112).

	Soil 19	Soil 20	Soil 21	Soil 22	Soil 23	Soil 24	Soil 25
Phytolith Morphology							
Keeled	20	11	45	22	6	8	17
Conical	35	12	42	42	7	16	41
Pyramidal	20	3	14	16	4	11	11
Crenate	6	6	4	2	-	4	2
Saddle, squat	41	21	61	68	1	15	47
Saddle, tall	126	36	115	102	3	29	99
Stipa	9	3	5	5	1	1	8
Lobate, Simple	3	3	1.5	2	1	1	1
Lobate, Panicoid	60.5	41.5	13	9.5	4.5	53	6
Lobate, Pan'd (compound)	-	-	-	-	-	-	-
Cross, Panicoid (<12 um)	17	7	3	-	1	2	-
Cross, Panicoid (>12 um)	17	9	1	-	1	5	-
Maize Rondel	-	-	-	-	-	-	-
Dicot, knobby	-	1	-	1	-	1	-
Spiny spheroid	2	2	-	2	2	3	-

Table B-6. Soil Sample Phytolith Counts, Samples 19 Through 25 (41RB112) (cont.)

WWW, Schlerid	-	-	-	4	1	3	6
Diatom	2	1	-	11	-	1	7
Sponge spicule	-	2	-	-	-	-	1
Trichome, Hair Cells	11	13	11	10	1	4	11
Bulliform, square	8	13	25	13	16	8	12
Bulliform, rectangular	32	34	37	36	33	26	46
Bulliform, keystone	13	18	30	33	15	5	10
Bulliform, Y-shaped	2	2	7	1	-	1	8
Bulliform, other	94	80	145	134	85	44	74
Elongate, smooth	15	9	14	4	9	20	3
Elongate, sinuous	8	6	11	11	17	13	4
Elongate, castillate	16	10	7	10	9	2	4
Elongate, spiny	2	-	2	7	-	2	1
Other Misc. Forms	-	-	-	-	-	-	-
Charcoal	27	34	26	23	62	14	8
Possible Pinaceae tracheid elements ?	-	35	-	-	-	9	-
Sedges	2	2	-	6	-	1	2
Saddle Imposters	9	1	6	8	1	1	-
Large Discs	5	-	6	1	1	-	-
Spore	-	-	-	1	-	-	-
Total Short Cells:	354.5	152.5	304.5	268.5	29.5	145	232
Pooids (cool season)	81	32	105	82	17	39	71
Chloridoids (hot dry)	167	57	176	170	4	44	146
Panicoids (warm moist)	106.5	63.5	23.5	16.5	8.5	62	15
Normalized Short Cells (%)							
Pooids	22.9	21	34.5	30.6	57.6	26.9	30.6
Chloridoids	47.1	37.4	57.8	63.3	13.6	30.3	62.9
Panicoids	30	41.6	7.7	6.1	28.8	42.8	6.5
Total Bulliforms	149	147	244	217	149	84	150
Ratio Bulliform:Short Cells	0.42	0.96	0.8	0.81	5.05	0.58	0.65
Ratio Charcoal:Bulliform	0.18	0.23	0.11	0.11	0.42	0.17	0.05
Ratio Charcoal:Short Cells	0.08	0.22	0.09	0.09	2.1	0.1	0.03

total short cells were also calculated in an effort to assess phytolith stability and preservation.

The normalized seasonality data for the twelve short cell phytolith morphologic types (see Tables B-3 through B-6) grouped by subfamily are plotted in Figure B-11. These three seasonality groupings are:

1. pooids which are the are cool season grasses (keeled, conical, pyramidal, and crenate phytoliths),
2. chloridoids which are the hot dry season grasses (squat and tall saddle phytoliths), and the
3. panicoids which are the hot season grasses with higher moisture requirements than the chloridoids (simple lobate, panicoid lobate, panicoid polylobate [i.e., compound lobate], and panicoid cross phytoliths [the *Stipa* biloboates are also included in this category]).

These soil samples are culturally derived; thus, rather than the term phytolith seasonality forms in this report meaning climatic seasonal variation over the millennia, it simply refers to the climatic condition under which the plant(s) grew. Thus for instance, pooids would generally represent spring or fall vegetation, or vegetation growing along waterways. Gathering activities conducted in different select portions of the ecosystem would likely result in various botanical species being introduced to the site.

The burned phytolith incidence of the twelve phytolith short cell forms was calculated yielding percent burned phytolith ratios (Table B-7). Bulliform phytoliths actually occur in the leaves of most grasses; however, they are more concentrated in C_4 plants as the bulliform cells are actively involved in conserving plant water in hot environments through the mechanism of active leaf curling (i.e., the plant actively reduces the amount of leaf surface area exposed to the sun during hot weather). Thus bulliform cells help and enable C_4 plants to thrive in a hotter drier environment. Although bulliform cells are most abundant in C_4 plants, the total number of bulliform cells contributed by panicoids with their much greater biomass is likely much larger than a comparable number of chloridoid plants—even though both subfamilies are C_4 plants. The ratio of total bulliform cell counts to total short cell counts (see Tables B-3 through B-6) shows considerable variation in concentration between samples (Figure B-12). This variability is felt to reflect dissolution of short cell phytoliths due to high soil pH in some portions of the archeological site.

Of the twenty-five soil samples analyzed, seven samples have bulliform phytolith counts present at a ratio higher than five times the short cell phytolith content (Figure B-12; see Tables B-3 through B-6). Most interestingly, without exception, these seven samples are the same samples with the lowest short cell phytolith counts (Figure B-11 legend; see Tables B-3 through B-6). The on-site control (sample 9) from the swale between Components A and C has the highest observed relative bulliform concentration. The relative bulliform concentration in the modern off-site surface sample is low (sample 25). This data suggests that some phytolith dissolution is occurring at certain areas of the site which is selectively lowering the relative short cell phytolith count. The presence of carbonates in the soil under the pithouses indicates a basic soil pH; phytoliths are known to dissolve when the soil pH is too high (Piperno 2006:8, 22).

The explanation of the elevated bulliform concentration in the other six samples noted above is enigmatic. The two samples from the bottom of storage pits (sample 7, Feature 13 and sample 23, Feature 23) may indicate that the pits were preferentially used to store species with a higher bulliform content; bulliforms are more concentrated in C_4 species (chloridoids and/or panicoids) as these species contain the specialized cells which enable leaf curling that allows plants to conserve water in hot weather.

The bulliform concentration in the pithouse 1, storage pit Feature 13 is higher than any of the pithouse 1 floor samples (samples 1 through 3) or other related samples (samples 4 through 6 and 8). This could indicated high bulliform content plants were stored in the pit. Alternatively, the contributing botanicals could have been used to line or otherwise prepare the storage pit. The variable and at times extensive weathering observed in the site's bulliform sample (Figure B-13) suggests that the environmental conditions in some soil samples were such that phytolith preservation is poor.

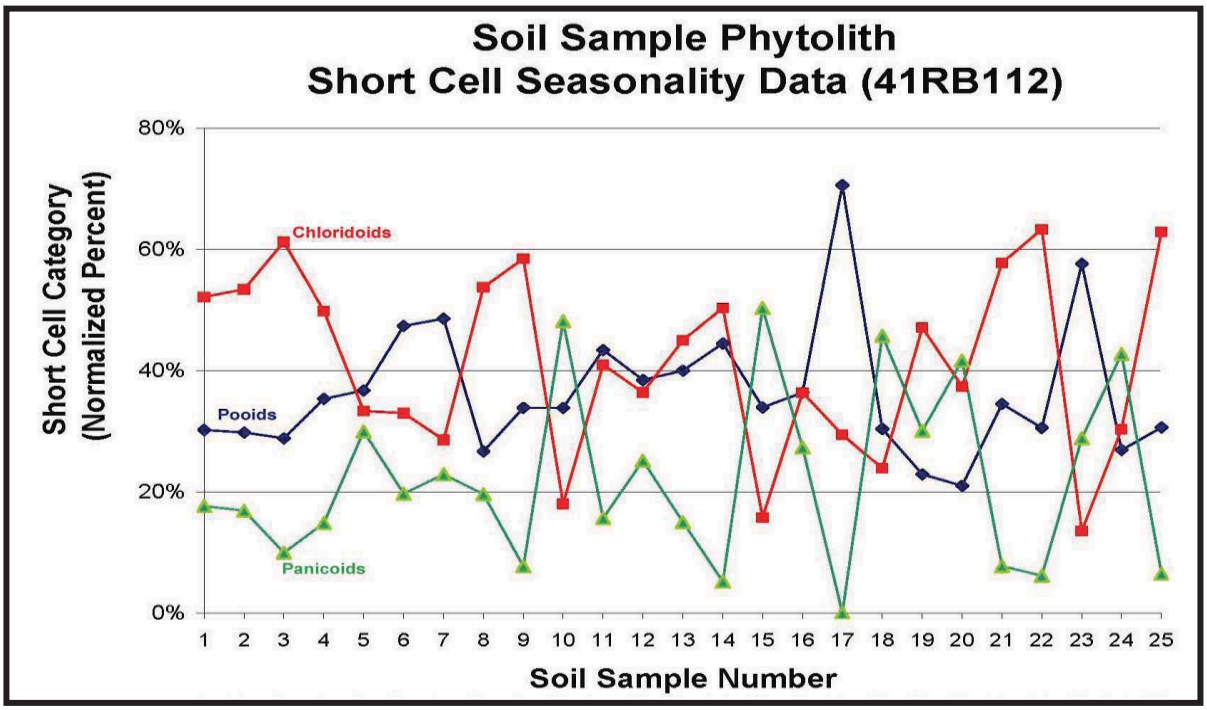

Figure B-10. Phytolith growing season plot of summed normalized short cell phytolith data. The particle counts for samples 7 [bottom of small storage pit, Feature 13], 9 [lower part of thickened A horizon in swale between Components A and C], 13 [north wall profile inside and on floor of pithouse 2, Feature 6], 15 [middle of earthen construction fill inside pithouse 2, western side, Feature 6], 16 [upper part of pithouse 2 floor below earthen construction fill, western side, Feature 6], 17 [bottom of pithouse 2 floor, western side, Feature 6], and 23 [inside, bottom of storage pit, Feature 23] were extremely low and thus have poorer reliability than the other samples as far as climatic indicators. The modern control surface soil is sample 25. Component A samples are 1 through 8, sample 9 is Component B, and samples 10 through 24 are from Component C. Other sample origin information is: soil sample 1 (from cutbank profile, base of pithouse 1, Feature 1), sample 2 (from profile wall, floor of pithouse 1), sample 3 (from floor of pithouse 1), sample 4 (inside west half of small basin heating element, Feature 8), sample 5 (southwest part of broad heating element, Feature 10), sample 6 (inside heating element, Feature 11), sample 8 (ashy stain next to heating element Feature 10), sample 10 (bottom of basin heating element Feature 5), sample 11 (pithouse 2 floor, Feature 6), and sample 12 (lower portion of construction fill on top of floor, Feature 6), sample 14 (upper end of eolian fill on top of construction fill towards western side of pithouse 2, Feature 6), sample 18 (earthen construction fill near center of pithouse 2, Feature 6), sample 19 (pithouse floor, upper, near center of pithouse 2, Feature 6), sample 20 (pithouse floor near center of pithouse 2, Feature 6), soil sample 21 (bottom of basin heating element with burned maize cobs, Feature 16), sample 22 (bottom of heating element with burned maize cobs, Feature 20), and sample 24 (ashy stain on floor of pithouse 2, Feature 24 in Feature 6 eastern end).

Table B-7. Percent Burned Short Cell Phytoliths in Each Soil Sample Scanned.

Soil Sample Number	1	2	3	4	5	6	7	8	9	10	11	12	13
Morphology / Percent Burned													
Keeled													
Conical		7.70%						8.70%		9.10%	2.90%		
Pyramidal										20.00%		5.00%	
Crenate										33.30%			
Saddle, squat													
Saddle, tall	1.20%		2.00%										
Stipa								20.00%		5.60%			100%
Lobate, Simple										5.60%		25.00%	100%
Lobate, Panicoid	12.50%	6.70%	5.90%	11.40%	13.40%	2.60%	46.70%	20.40%		16.90%	15.20%	14.80%	
Lobate, Panicoid (cmpd)													
Cross, Panicoid (<12 μ)	50.00%		33.30%					33.30%		32.30%	50.00%	33.30%	
Cross, Panicoid (>12 μ)										33.30%		33.30%	

Soil Sample Number	14	15	16	17	18	19	20	21	22	23	24	25
Morphology / Percent Burned												
Keeled					4.80%							
Conical						2.90%		2.40%		14.30%	12.50%	
Pyramidal											9.10%	
Crenate					11.10%							
Saddle, squat						2.40%						
Saddle, tall							2.80%					
Stipa						11.10%						
Lobate, Simple								66.70%				
Lobate, Panicoid		12.70%	10.00%		3.40%	11.60%	14.50%				15.10%	16.70%
Lobate, Panicoid (cmpd)												
Cross, Panicoid (<12 μ)	100.00%				14.30%	11.80%	14.30%	33.30%				
Cross, Panicoid (>12 μ)						5.90%					40.00%	

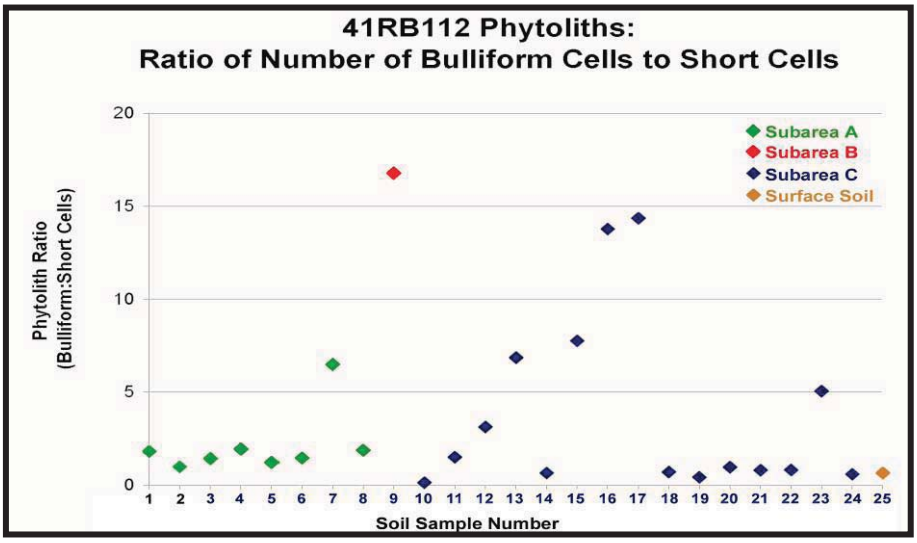

Figure B-11. Ratio of bulliform phytolith counts to short cell phytolith counts (data from Tables B-3 through B-6).

Well preserved and poorly preserved bulliform specimens were intermixed in the soils. Perhaps most significant is the specimen shown in Figure B-13U; the upper half of this rectangular bulliform is in pristine condition while the lower half is totally missing; one interpretation of this specimen would be that the phytolith protruded from a ped surface and the half exposed to ground water movement was dissolved. The ratio of charcoal to short cell phytolith count is also somewhat increased for the same seven samples (see Tables B-3 through B-6). This observation suggests that the smaller particles may be disappearing over time in an unfavorable soil environment whereas the larger particles with a smaller surface to volume ratio (i.e., bulliform phytoliths) take longer to dissolve (i.e., a large ice cube melts more slowly than a small ice cube). The bulliform phytoliths show evidence of weathering and partial dissolution (Figure B-13), but portions of bulliforms remain in the soil and are recoverable and countable whereas many of the smaller short cell phytoliths were apparently completely dissolved thus resulting in an artificially environmentally-induced low short cell phytolith count which is what is observed in the counts for some soil samples.

The key to understanding the soil samples in pithouse 2, Feature 6 in Component C with the higher/more abundant relative bulliform content may hinge on the description provided for soil sample 14 ("upper end of eolian fill on top of construction fill towards western end of pithouse"). Once the structure was compromised, the exposed part of the abandoned pithouse would potentially develop a new botanical signature as degradation continued. The area would be a low spot, which would tend to concentrate the little bit of available water, and the effects of that higher water concentration in this local micro-environment could potentially have altered relative phytolith preservation. The higher bulliform ratio concentration samples in pithouse 2 tend to cluster on the west side of the structure which may suggest that this was the area available for vegetative growth [or selective dissolution] during the eolian period (sample 15 [middle of earthen construction fill inside pithouse 2, western side], 16 [upper part of pithouse 2 floor below earthen construction fill, western side], and 17 [bottom of pithouse 2 floor, western side], with sample 13 [north wall profile inside and on floor of pithouse 2] being the outlier from this interpretation. The other two slightly elevated bulliform soil samples (samples 11 [pithouse 2 floor] and 12 [lower portion of construction fill on top of floor], were also floor-related pithouse 2 samples; they had slightly elevated bulliform ratios of 1.5 percent and 3.1 percent). An alternative explanation

for the relative high bulliform concentration in these two samples is that the bulliform-rich botanical species may have been used in pithouse 2 construction, maintenance, and/or for sustenance; bulliforms are more abundant in the C_4 grasses (on a plant by plant basis, panicoids would presumably be favored as the source over chloridoids as the panicoids have much more biomass).

Sedge (Cyperaceae) phytoliths and sections of sponge spicules (Porifera) were also recovered (see Tables B-3 through B-6); no sponge gemmoscleres were observed in the slides. Sedges produce distinctive phytoliths, and frequently grow in wetland areas. The proximity to the creeks and local drainage system explains their presence at the site; they may have been actively gathered for use, or incidental (animal droppings, eolian deposit). Sponges live in water; when they die their microscopic skeletal support network (spicules) are released into the environment. Freshwater sponge spicules are made of biogenic silica (as are phytoliths)—so, they may be recovered in soil phytolith isolates. Complete spicules are gradually chipped, broken, and weathered as they are transported downstream with the sands [or blown as part of the dust]. Thus, fresh pristine spicules (such as those accidentally transported to the site when water was hauled for cooking or drinking) are suggestive of a local sponge population. At the other extreme, weathered spicules can and do occur in soil and sands, and can be transported, deposited, and redeposited by water and/or wind. In the process of this movement, the spicules collide repeatedly with other particles and they begin to show visible signs of abrasion and weathering (i.e., literal "sandblasting") (Sudbury 2011c). Such weathered spicules occur at the site, but they are redeposited rather than representing an extant local sponge population. Sedges would have been transported to the site rather than growing on the site. Sponge spicules sections were present in the local environment without human intervention. Gemmoscleres (special spicules formed during the resting or dormant phase in the sponge's life cycle) were not recovered at the site.

Several other distinctive phytolith forms were noted: one specimen of a Commelinaceae seed phytolith was found (Figure B-14). This was tentatively identified as being a member of the Commulina genera (Yost personal communication) of which there are four species native to the USA: *C. dianthifolia, C. diffusa, C. erecta,* and *C. virginica* (Yost 2011). Several very distinctive examples of phytoliths exhibiting characteristics of a sedge (raised central area) but exhibiting a large jig-saw puzzle piece type edge were recovered (Figure B-15); the botanical source of these phytoliths remains unknown.

In the formal sample particle counts for short cell phytolith frequency (see Tables B-3 through B-6), possible tracheid phytoliths were in the soil sample phytolith isolates from pithouse 2, Feature 6 floor samples 14, 18, 20, and 24 (Figure B-16) [all four of these soils have what is interpreted as good short cell preservation (see Figure B-12)]. During the formal counts, no tracheid specimens of this morphology were observed in Components A and B samples (samples 1 through 10) or in the off-site control sample (sample 25). In the rescans of the specimen slides looking for additional particles of interest, photographs were taken of all observed similar possible tracheid elements; those total particle counts [based on photographs] are:

soil 11: 1 example (pithouse 2 floor, Feature 6),
soil 13: 1 example (north wall profile inside and on floor of pithouse 2),
soil 19: 1 example (pithouse floor, upper, near center of pithouse 2),
soil 17: 2 examples (bottom of pithouse 2 floor, western side),
soil 18: 9 examples (earthen construction fill near center of pithouse 2),
soil 15: 11 examples (middle of earthen construction fill inside pithouse 2, western side),
soil 24: 26 examples (ashy stain on floor of pithouse 2, Feature 6 eastern end),
soil 16: 36 examples (upper part of pithouse 2 floor below earthen construction fill, western side), and
soil 20: 82 examples (pithouse floor near center of pithouse 2).

Again, during these additional scans no specimens of this phytolith type (fragments or whole) were observed in the samples from Components A or

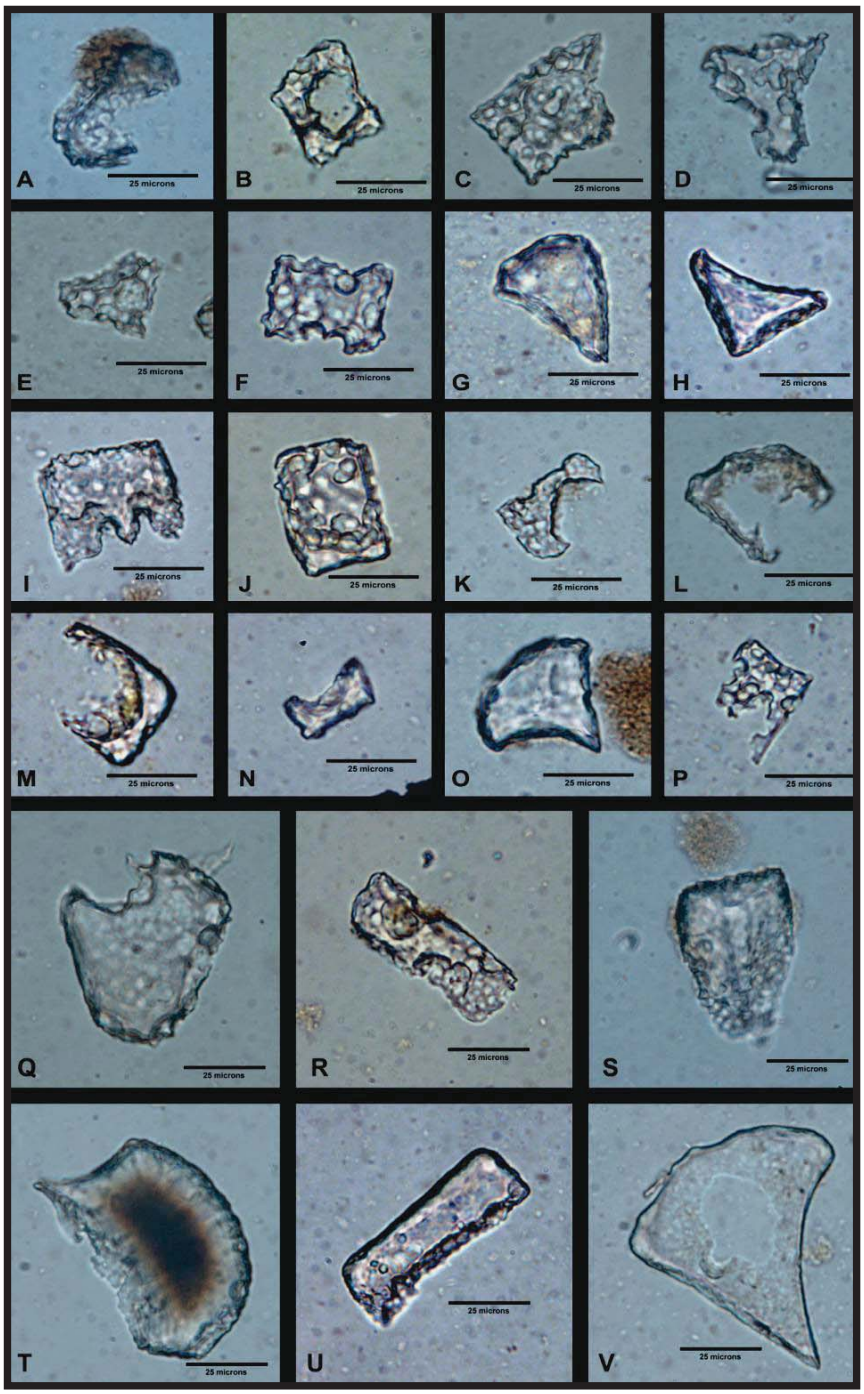

Figure B-12. Representative weathered bulliform phytoliths.
A through C and Q: sample 7 (bottom of small storage pit, Feature 13); D: sample 8 (ashy stain next to heating element Feature 10); E and F: sample 9 (control between Components A and C); G through K, R through S: sample 12 (lower portion of construction fill pithouse 2, Feature 6); L, T: sample 15 (middle of earthen construction fill western side, Feature 6); M through O, U through V: sample 16 (upper part of pithouse 2 floor below fill western side Feature 6), and P: sample 17 (bottom of pithouse 2 floor, western side of Feature 6).

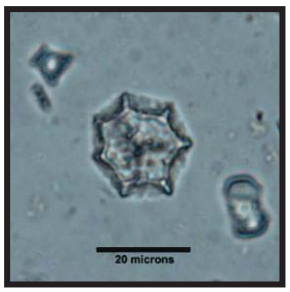

Figure B-13. Commelinaceae seed phytolith.
Soil sample 20 (pithouse floor near center of pithouse 2, feature 6)

B—these phytoliths only occurred in Component C soils.

In Bozarth's paper reporting the Pinaceae blocky bordered pit tracheid elements, the control conifer specimens examined were more northern species: balsam fir (*Abies balsamea*), white spruce (*Picea glauca*), black spruce (*Picea mariana*), jack pine (*Pinus banksiana*), and larch (*Larix laricina*) (Bozarth 1993:98). These tracheid elements with bordered pits were reported as common in jack pine (18 percent) and less common in white spruce at (1 percent) (ibid.). In an effort to identify the botanical source of the phytoliths illustrated in Figure B-16, phytoliths from reference specimens of honey mesquite (*Prosopis glandulosa*, Figures B-18 through B-21), Rocky Mountain juniper (*Juniperus scopulorum*, Figures B-22 through B-26), common juniper (*Juniperus communalis*), eastern redcedar (*Juniperus virginiana*), ponderosa pine (*Pinus ponderosa*), limber pine (*Pinus flexalis*), Douglas-fir (*Pseudosuga* sp.), lodgepole pine (*Pinus contorta*), subalpine fir (*Abies lasiocarpa*), Piñon pine ("twoneedle pinon" *Pinus edulis*), and blue spruce (*Picea pungens*) were isolated and examined [when available, samples were ashed and mounted (with and without hydrochloric acid treatment) from cones, seeds, needles, small limbs, and bark shavings from limbs greater than 1 inch]. Phytoliths were also prepared from cottonwood (*Populus* sp.), hackberry (*Celtis* L.), pecan (*Carya illinoinensis*), and quaking aspen (*Populus tremuloides*). To date, the botanical source(s) of the phytoliths in Figure B-16 remains unidentified; they were not observed in these reference specimens. The most similar appearing phytoliths were observed in Rocky Mountain juniper (see Figure B-26), but they do not match the unknown specimens in Figure B-16. The specimen illustrated in Figure B-25N, P, and R is a narrow ribbon-like specimen, but differs in that it is crystalline rather than amorphous (the Figure B-16 specimens are amorphous) and they do not have the same surface detail.

The other unusual particles observed in the soil sample phytolith isolates are thought to be remains of plant fibers (see examples in Figure B-17). Perhaps the most striking feature observed in these fibers besides the crystallinity is the incised, X, or cross-hatched pattern that is most visible in the specimens B-17A, F3, and F5. A similar appearance is visible in Figure B-25T observed in the Rocky Mountain juniper control sample. However, as positive identification of the unknown fibers in Figure B-17 is currently not possible as we are current unable to excluded fibers that occur in other plants not yet examined.

Large flat disk-shape phytoliths, also referred to as rondels, were observed in a number of soil phytolith isolate slides; these specimens were further evaluated to determine if they originated from *Zea mays* (Piperno 2006: Figure 2. *Zea*, p. 49). A number of specimens of this general type of rondel are illustrated in Figure B-27. The disk-shaped rondels with appropriate upper surface contour or ornamentation when examined three dimensionally are classified as originating from *Zea mays* cobs. Those meeting the three dimensional morphologic criteria described by Pearsall, Chandler-Ezell, and Chandler-Ezell (2003) were specimens in

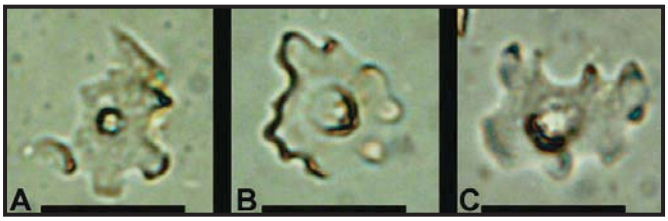

Figure B-14. Unusual phytolith form(s) recovered from three soil samples:
A: sample 18 (earthen construction fill near center of pithouse 2, Feature 6), B: sample 20 (pithouse floor near center of pithouse 2), and C: sample 24 (ashy stain on floor of pithouse 2, Feature 6 eastern end). The bar scales are 20 microns.

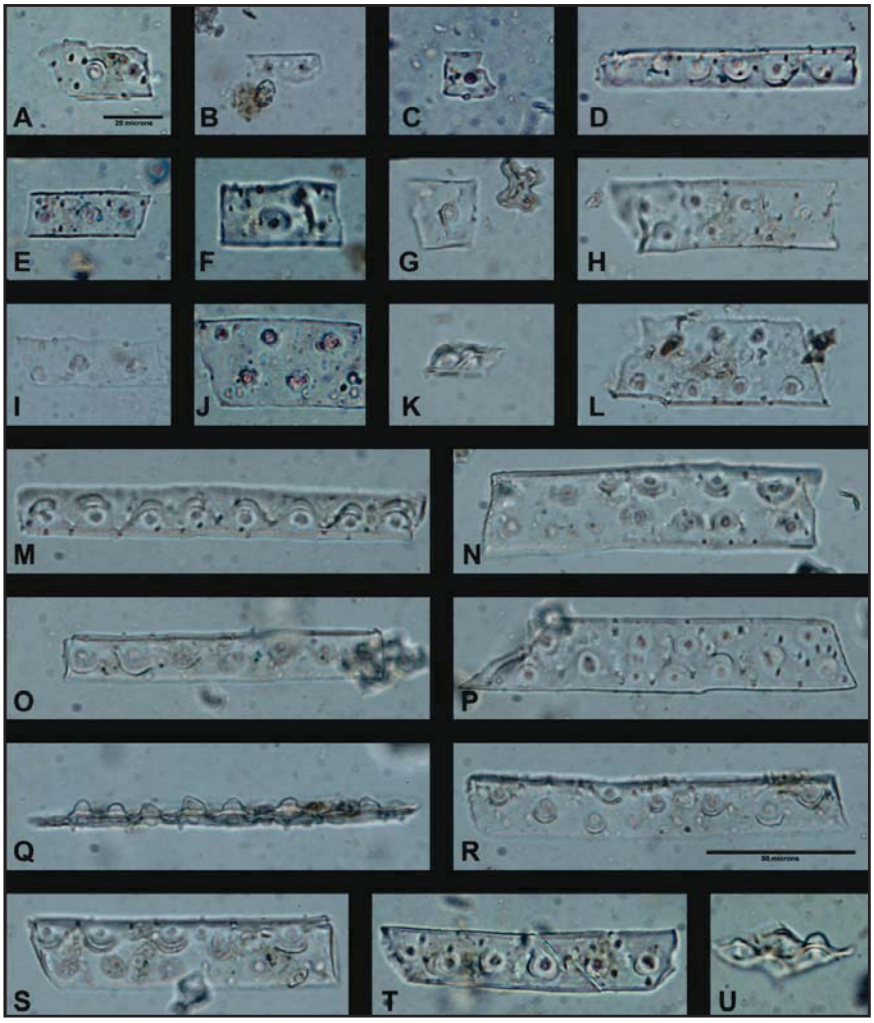

Figure B-15. 41RB112 possible tracheid elements from the ashy stain Feature 24 on the floor of pithouse 2 Feature 6, eastern end (sample 24).
Images Q and U are side (edge) views, K is an angle view, and the other shots are planar views. The 20 (A) and 50 (R) micron scales apply to all images. Many of these specimens—over 100 microns long—would normally be left in the sand fraction (> 50 microns) by the standard separation procedure as it appears in the literature.

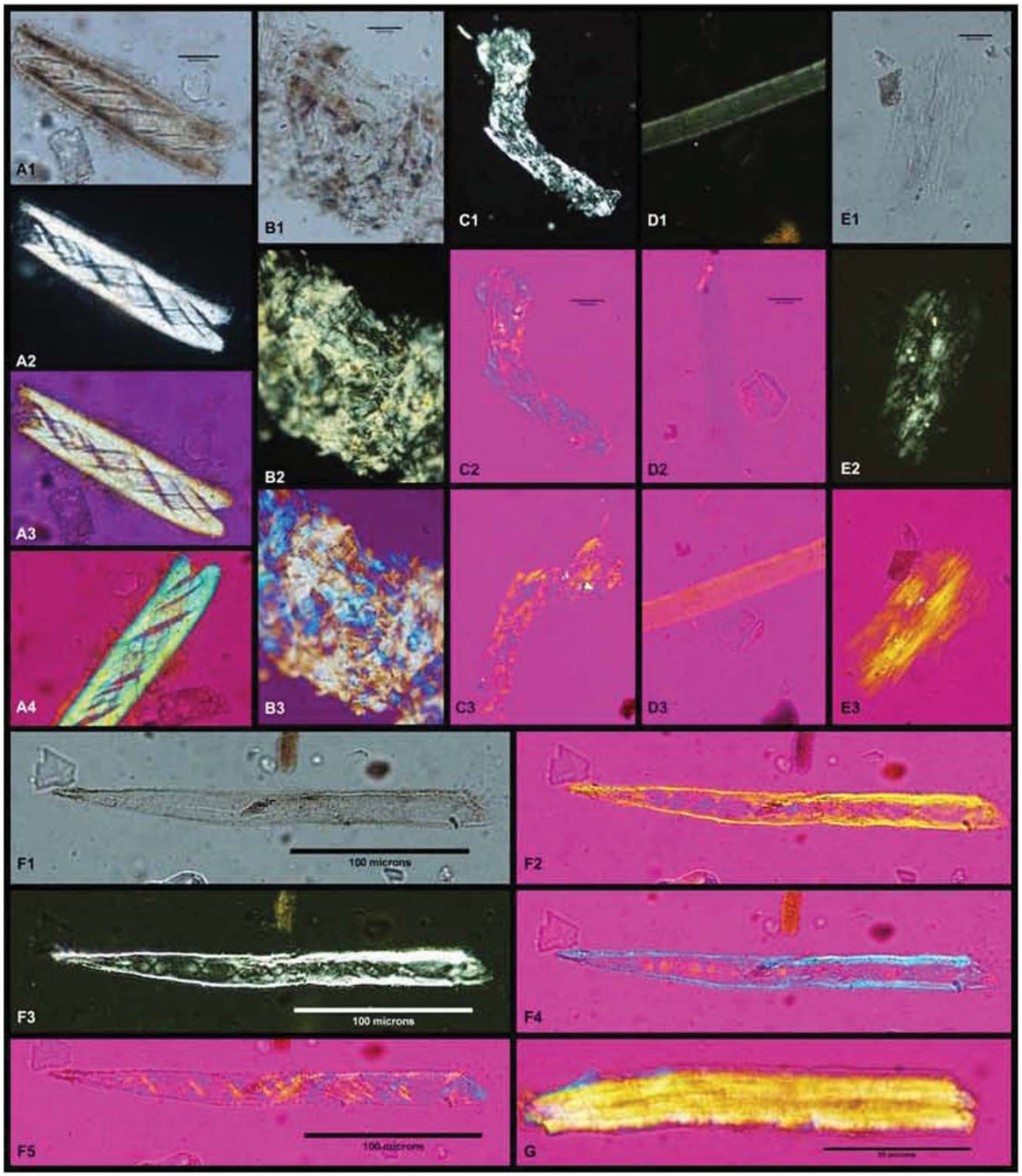

Figure B-16. Various views of example fiber residues recovered from soil samples during phytolith processing (plus one Rocky Mountain juniper control fiber).

A, B: Soil sample 7 (bottom of small storage pit, Component A); C: control Rocky Mountain juniper cone fiber; D Soil sample 6 (inside heating element, Component A); E Soil sample 15 (middle of earthen construction fill inside pithouse, Component C); F and G: soil sample 23 (inside bottom of storage pit). Grey background photographic images are illuminated via polarized light; black backgrounds are via crossed polars, and reddish backgrounds are crossed polars with ¼ wave plate in place (yellow fiber change to blue color occurs by rotating the specimen stage 90°).

Figure B-17. Honey mesquite (*Prosopis glandulosa*).

A: Part of mesquite specimens as received from Mike Quigg (1-large branch, 2-small limb, 3-smaller limb with thorns, 4-petiole, 5-leaves, and 6-seed pod). B: seed pod (1), seeds removed from pod (2), and seed components (3; see D). C: thorns and accompanying stem section (visible in A3). D: seed components (row 1-intact seeds, 2-seed, 3-seed coats). E: eight samples before ashing (1-seeds [D2], 2-seed coats [D3], 3-seed pod husk [legume pericarp], 4-leaves [A5], 5-small limbs [A2], 6-petioles [A4], 7-thorns [C], and 8-limb section at base of thorns [C]. F: samples after ashing [1-8 the same as E; crucible #9 was added as there was additional room available in the muffle furnace; #9 contains bark sections from the larger limb [A1]). In most samples in F, the white ash contains a significant amount of carbonate. Slides were prepared from the ash as shown. Part of the ash was later treated with hydrochloric acid to remove the carbonates; after rinsing and drying, the remaining residue was also mounted on slides for examination.

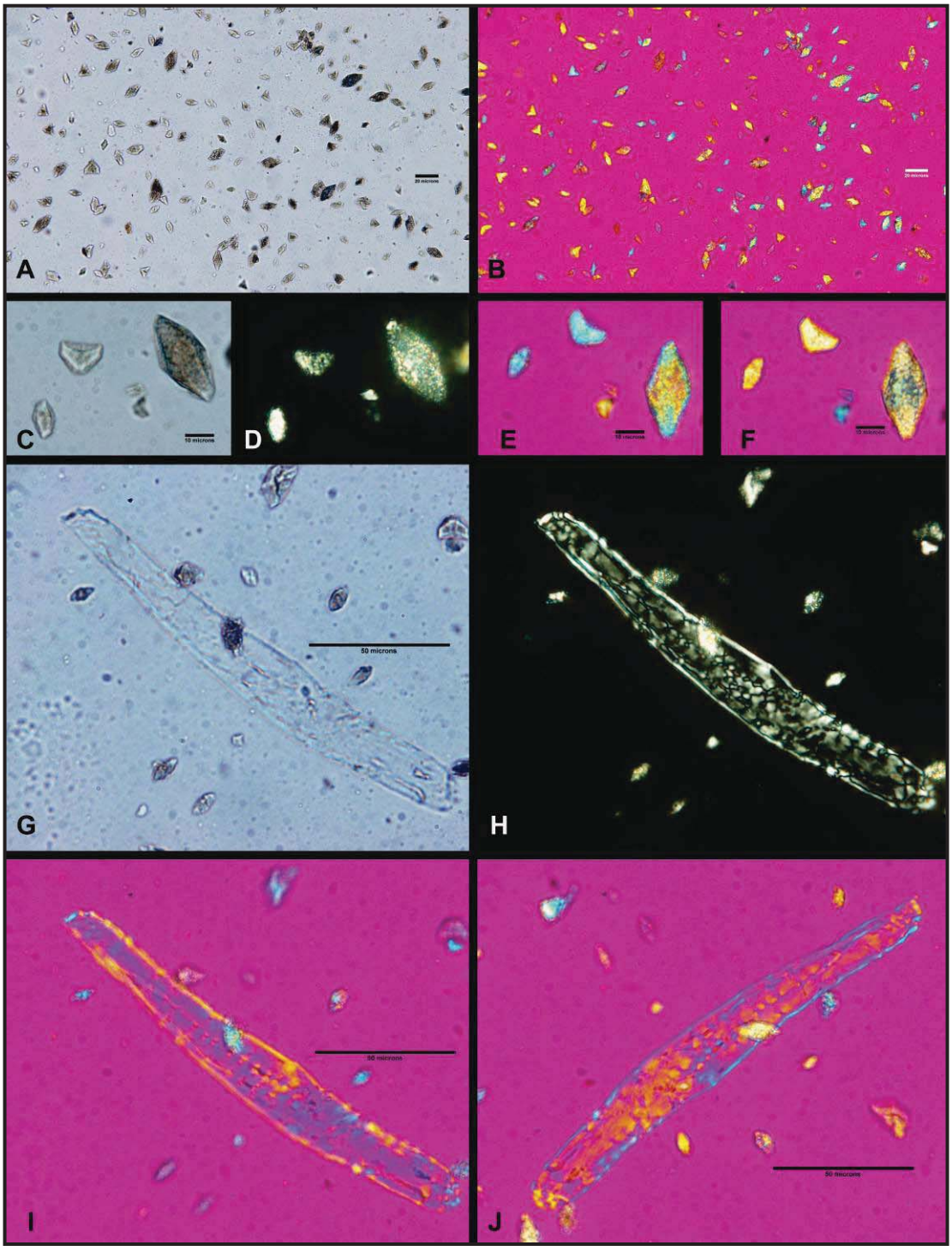

Figure B-18. Honey mesquite small limb phytoliths (thermally ashed samples, neutralized with HCl)—calcium oxalate crystals, and crystal-bearing fibers.

A through B: Imaged show profusion of calcium oxalate crystals from the small limbs. C through F: four views of example crystals (F was rotated 90° from E). G through J: four views of fiber containing oxalate). A, C, G-polarized light; D, H-crossed polars, B, E, F, I, J-crossed polars with quarter-wave plate).

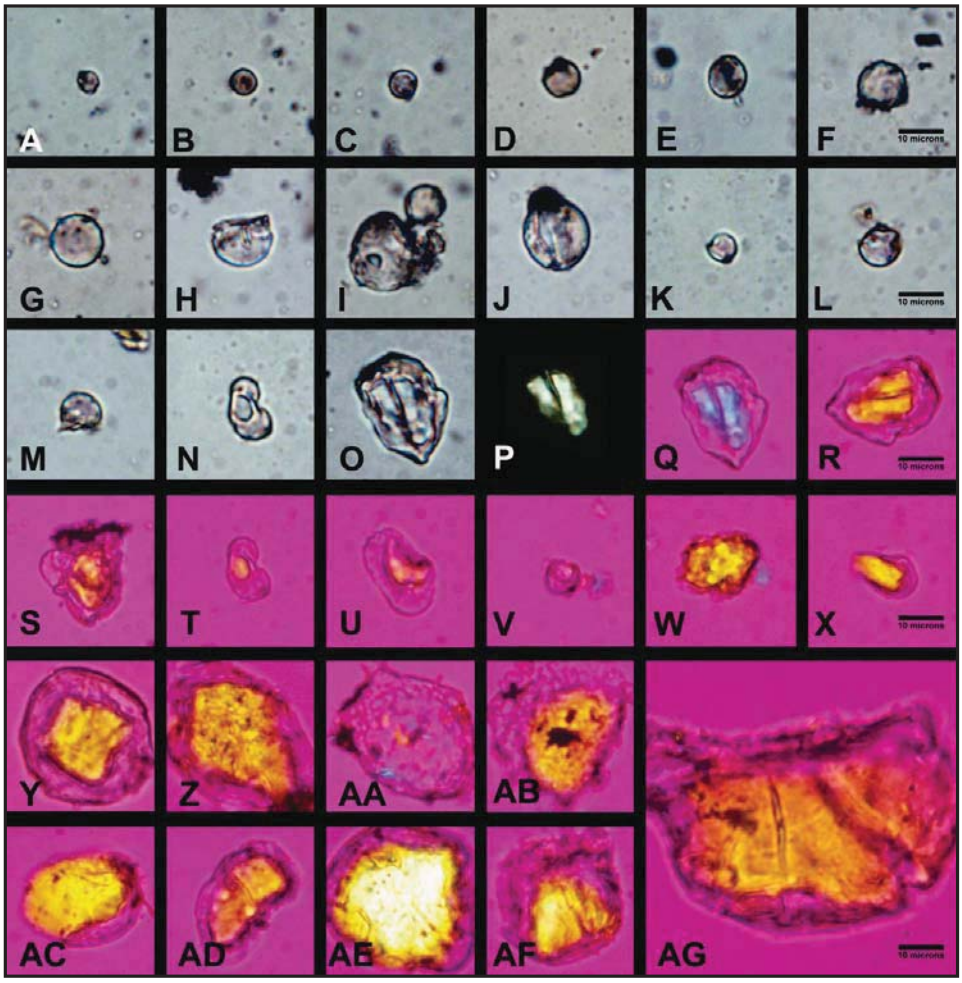

Figure B-19. Honey mesquite tree phytoliths—spheres and crystalline material. A through M: spherical phytoliths. N through AG: phytoliths associated with crystalline materials. Mesquite leaves: A though J, O through S; Mesquite petioles: K through N, T through X. Mesquite seed coat: Y through Z [also note the specimen in Figure B-21:H through K]; and Mesquite seed pod husk [legume pericarp]: AA through AG. The leaves had an abundance of variable size spherical phytoliths (A through J); specimen J is interesting in that a crystal appears to be growing out of a large sphere; the crystal also present in N (see same specimen in T). The petioles also had a few spheres (K through N); N actually appears to be co joined spheres with a crystal forming at the juncture. Two-part particles were also noted with a base or outer portion of biogenic silica and a central crystalline material. The series O through R shows one complete set of images (O: polarized light, P: crossed polars; Q through R crossed polars with quarter wave plate) [the remaining images (S through AG) just show the final quarter wave plate view]. There is considerable variation in crystalline material size and shape; the particles in the seed coat and pod husk (legume pericarp) tend to be larger. AA looks similar—but does not contain the crystalline component. V looks like a small sphere with a central crystal.

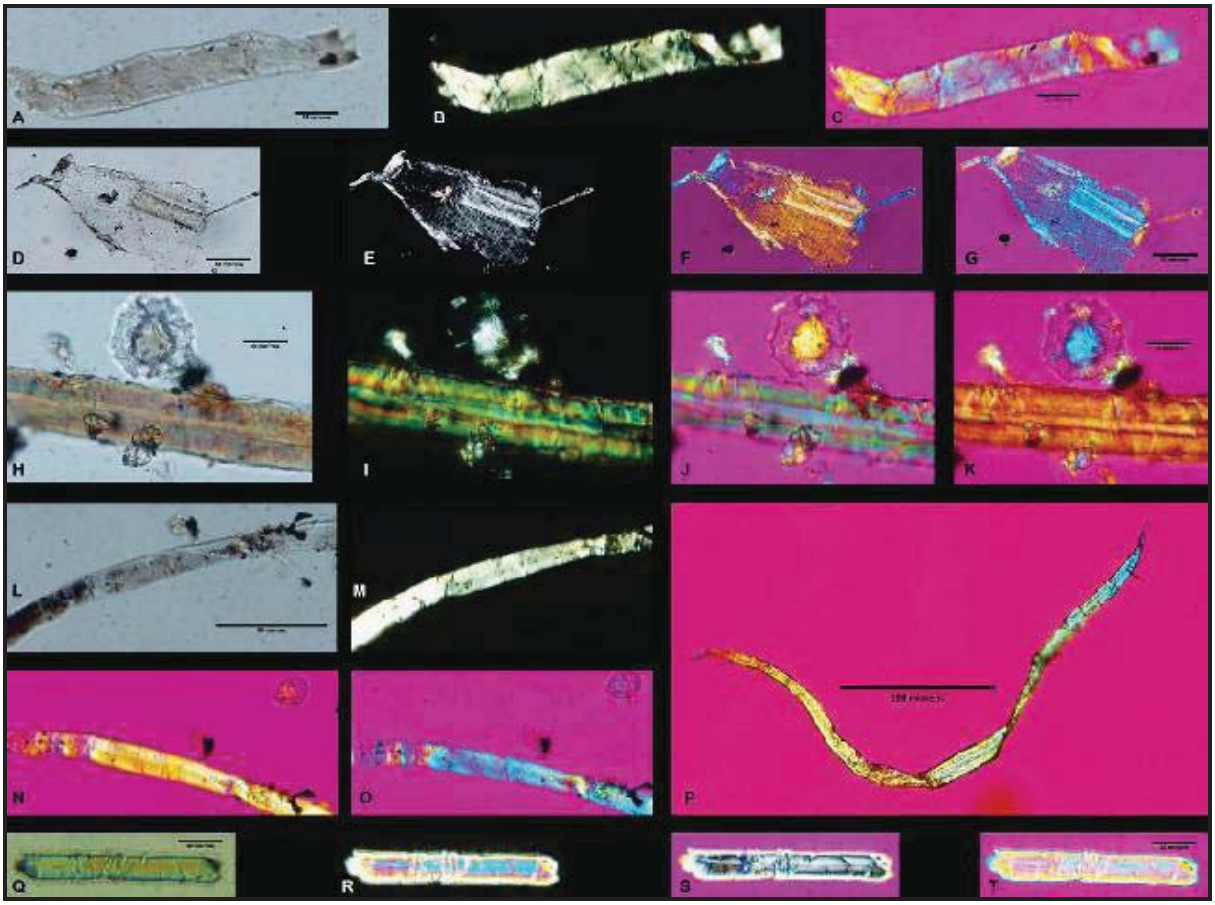

Figure B-20. Honey mesquite tree fibers (after thermal ashing to 530°C and hydrochloric acid treatment).

A through K: from seed coat [Figure B-20D3); L through T: from husk of seed pod ([legume pericarp] note variable scales; polarized, cross polarized, and quarter wave plate images as described previously [one view missing in the A through C series; images G, K, and O rotated and reoriented for easier visualization).

Seed Coat: A through C: fiber showing crystalline component after ashing and HCl treatment. The tracheid element shown in D through G is much larger and has a mesh-like appearance. In the H through K series, a different crystalline component (or mixture) is present as evidenced by the color change in I and J. The upper circular particle is a spherical particle practically identical to the one shown in Figure B-22Y suggesting this form may be common in Mesquite seed coats. Pod Husk (legume pericarp): three different fibers illustrated (L through O, P, and Q through T). P is a complete fusiform-shaped fiber with the same evidence of crystallinity. The specimen in L through O is similar in composition to that observed in A through C. The specimen in Q through T has a different composition based on color difference. Identity of the crystalline components, at least some of which are presumed to be calcium oxalate-related, remains to be determined.

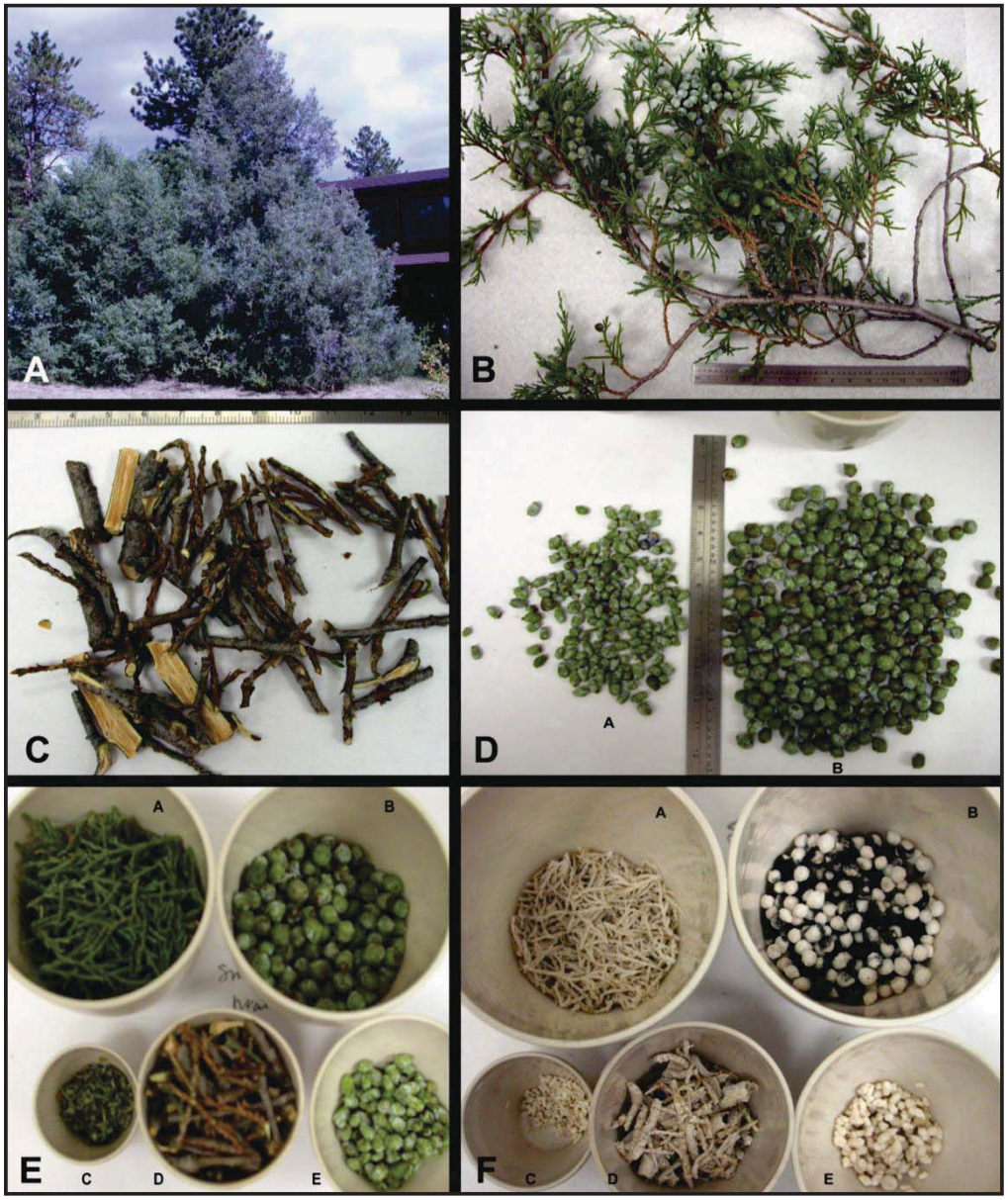

Figure B-21. Rocky Mountain juniper (*Juniperus scopulorum*).
A: Trees sampled on the east edge of Estes Park, Colorado (specimens provided courtesy of Bud Hampton; view to the SE) [top of a Douglas-fir visible in the background]; B: example small limb to be processed; C: small limb fragments (larger diameter pieces were split so they would ash more quickly); D: berry-like seed cones (A-narrow, not fully filled out; B-plump). E. Crucibles loaded ready for the furnace (A-leaves; B-plump seed cones, C-seed cone stems; D-small limb sections, and E-narrow seed cones), and F. same composition as image E after ashing at 530°C. Specimen slides were prepared from the ash as shown. Part of the ash was later treated with hydrochloric acid to remove the carbonates; after rinsing and drying, the remaining residue was also mounted on slides for examination.

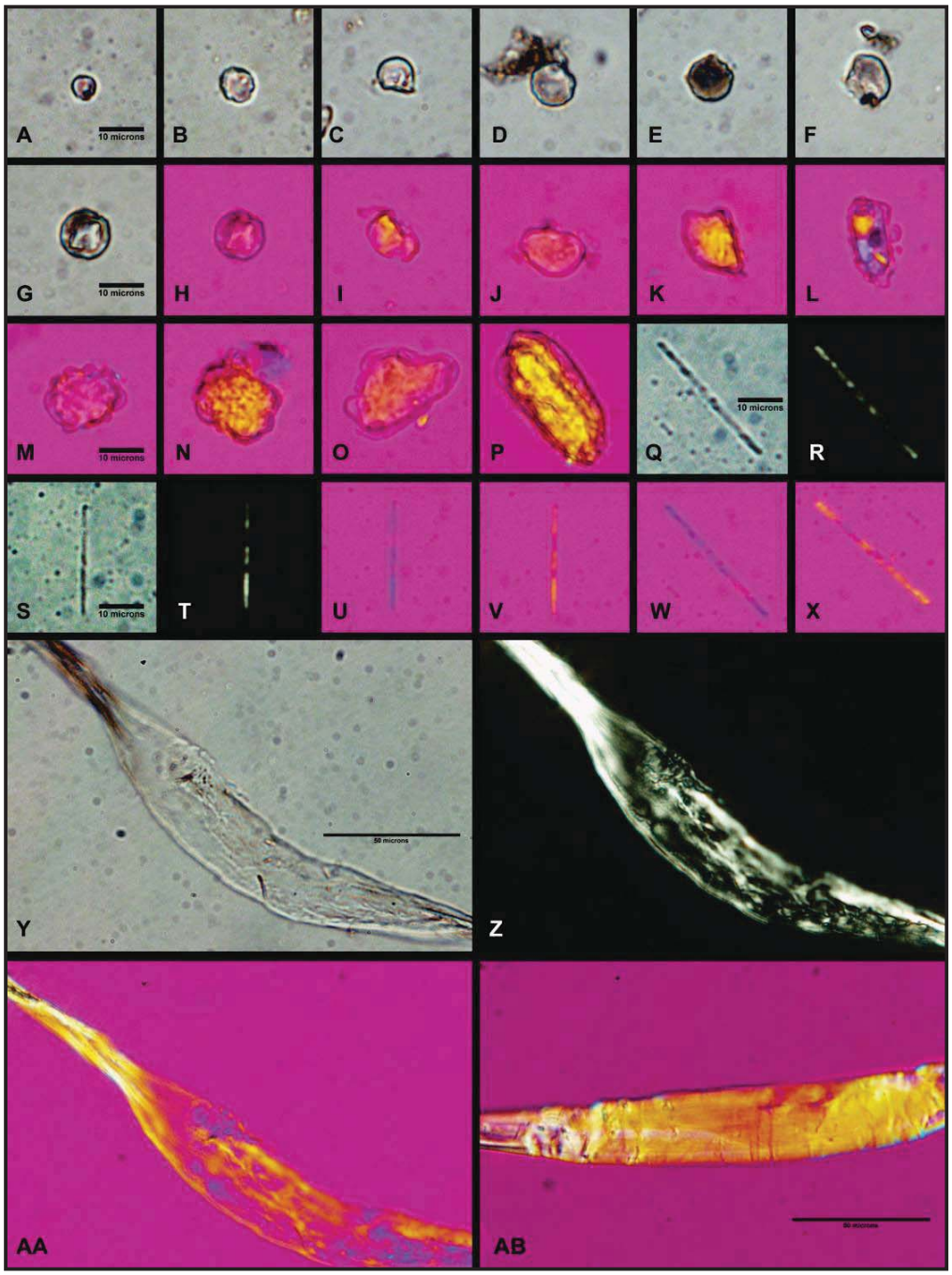

Figure B-22. Rocky Mountain juniper phytoliths from small limbs.

A through H: small spheres (the specimen in G and H contains a central crystalline component); I through P: narrow phytolith border around crystalline center. Q through X: four views of two "wispy" crystalline fibers; and Y through AB: representative view of crystalline nature of two fibers. Images A through X all prepared at the identical scale. These microscopic specimens by prepared from the small limbs shown in Figure B-17C thermal ashing (530°C), HCl treatment, and mounting in Canada Balsam.

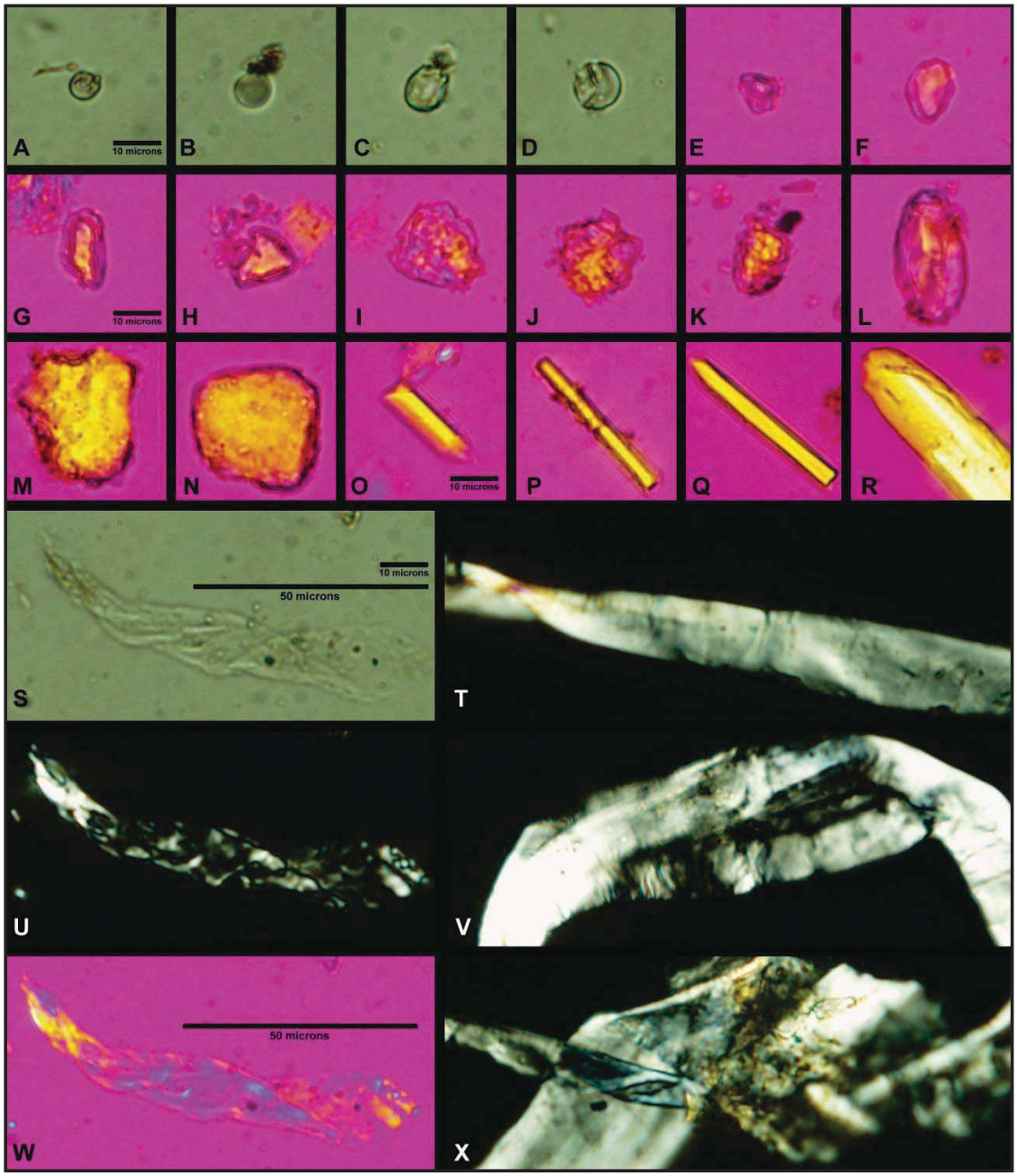

Figure B-23. Rocky Mountain juniper phytoliths prepared from leaves.
A though D: Spherical phytoliths; E through N: crystals associated with phytolith bases; O through R: pure isolated crystals (longer specimens were observed); S through X: images of four fibers (specimens S, U, and W are images of one fiber); T, V, and X are cross polars images of 3 additional sections of fibers at the same magnification).

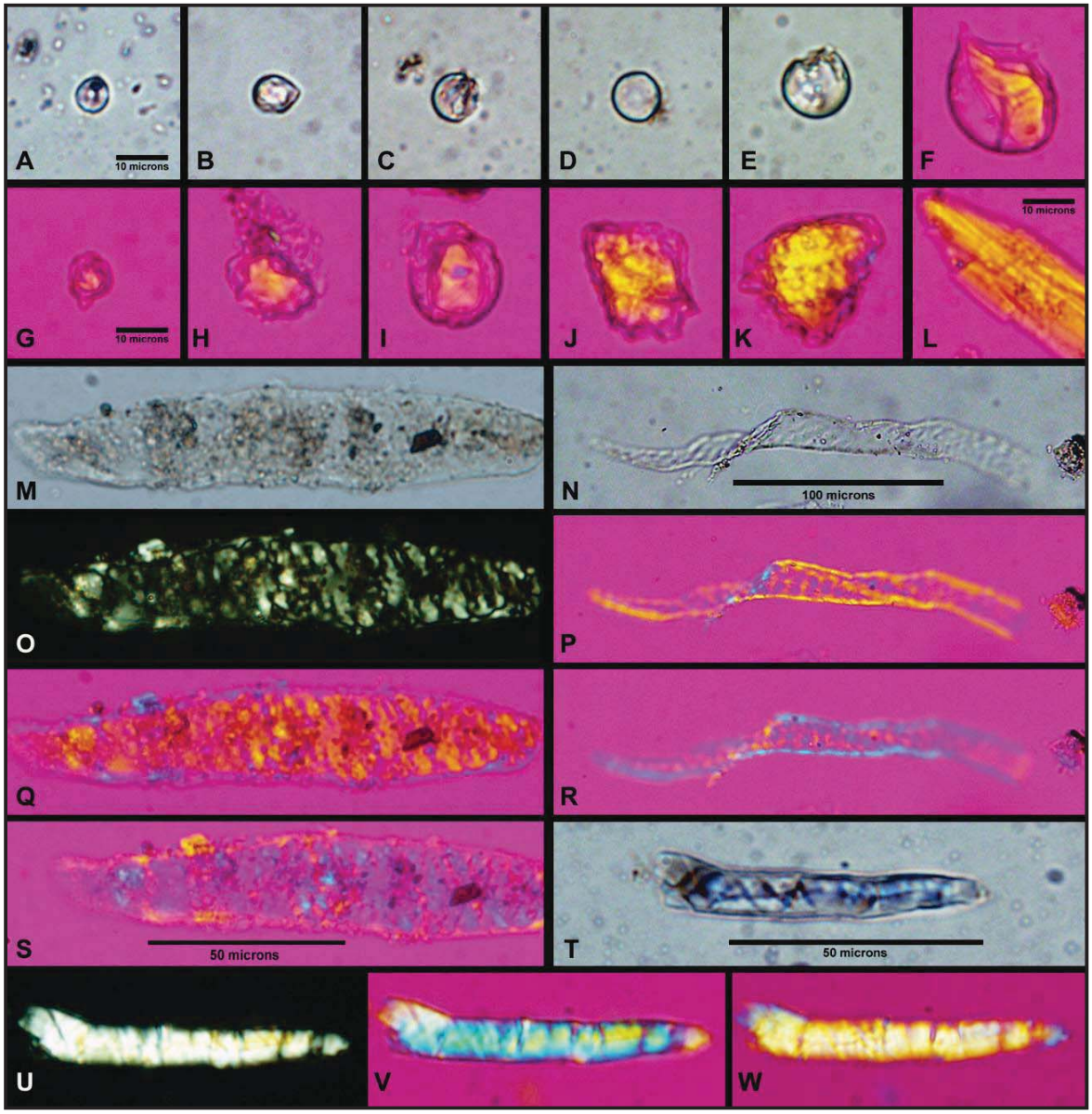

Figure B-24. Rocky Mountain juniper phytoliths and crystalline fiber residues prepared from berry-like cones.

A through E: spherical phytoliths; F: possible spherical phytolith; G through K: crystals from cells or associated with phytoliths; L: pure crystalline material; and crystalline residue from three apparent plant fibers (M, O, Q, and S; N, P, and R; and T, U, V, and W).

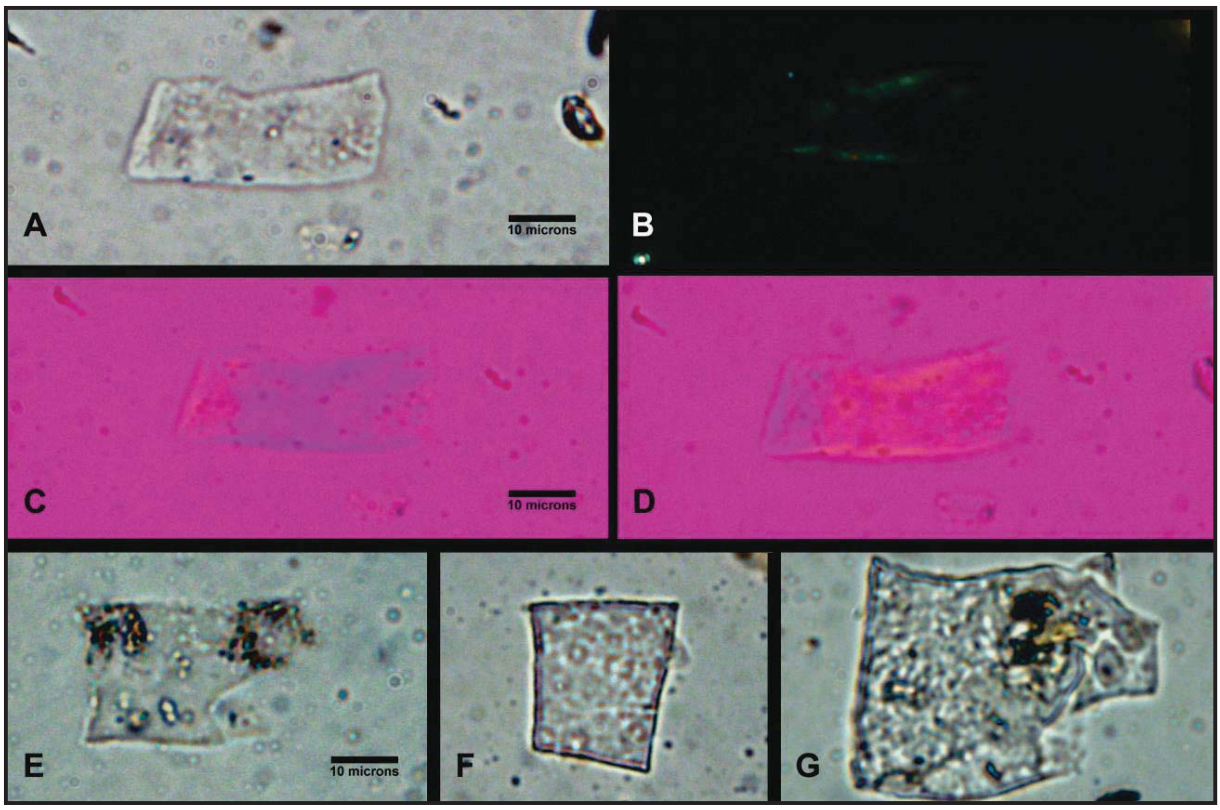

Figure B-25. Several generally rectangular phytoliths recovered from Rocky Mountain juniper leaves.

Although superficially similar, the morphology of these specimens is not the same as those recovered from the soil samples Figure B-16. Specimen A through D is from the ashed leaf sample; and the three specimens in E through G are from the seed-like cones.

Figure B-27A, D, E, G, H, and I (see also Piperno 2006:204). This phytolith originated from maize cobs. The other specimens in Figure B-27 are from non-*Zea Poaceae* species. Cross-shaped Panicoid phytoliths or cross-bodies (Piperno 2006:49) occur in a number of morphologic subtypes; Type 1 specimens wider than 12.57 microns are considered to have originated from maize leaves (ibid.: 45-65). A selection of cross-shaped phytoliths from 41RB112 is shown in Figure B-28; the bar scale with each images is 12.5 microns long. The phytoliths in A through O are wider than 12.5 microns and thus are considered to be indicative of maize leaves (specimen P is borderline in width). The remaining specimens are narrower than the criteria and thus are automatically felt to have originated from other Poaceae species.

The second criterion is the variant type; of the 8 variants, variant one is type that originates from maize (ibid. 200). Of the specimens in Figure B-28A through P, C through E are clearly variant 1 whereas J, L, and N through P are not variant 1; the remaining specimens (A, B, G through I, K, and M) are probably variant 1 (i.e., *Zea mays*). These specimens, from a sample of a basin heating element (Feature 5), clearly record that maize was present and that nonmaize Poaceae were also present. However, the non-maize species may have been harvested for other uses, or simply employed as tinder. Thus, Feature 5 (sample 10) contained both maize cob phytoliths (see Figure B-27) and maize leaf phytoliths (Figure B-28). Some, but not all of the crosses are burned (Figure B-28).

Another common resource was the cucurbits, which also produce distinctive spherical scalloped phytoliths (Bozarth 1986, 1987; Piperno 2006:65-71, 205-206). Phytoliths with either the correct size or general textural appearance from 41RB112 are illustrated in Figure B-29. As cucurbit species were domesticated, their phytoliths gradually increased in size (Piperno 2006:67). For easy reference Figure B-30 shows six cucurbit phytoliths prepared from a reference specimen of Buffalo Gourd (*Cucurbita foetidissima kunth*). Past literature generally shows pristine phytoliths; however, the range shown in Figure B-30 is much more realistic—from classic to pretty rough looking. Part of the difficulty in interpreting the 41RB112 cucurbit data in Figure B-29 is the issue with phytolith preservation at the site (see bulliform Figure B-13). A number of the phytoliths are too small to meet the published identification criteria (Figure B-29A through C, E, P, and Q and probably G and J). [To my knowledge, the phytolith size in immature cucurbits has not been studied or reported—that worthwhile investigation is currently being planned. The effect of environmental differences on cucurbit size and degree of silicification has been noted (Bozarth 1987:612.] Clearly, none of the remaining larger

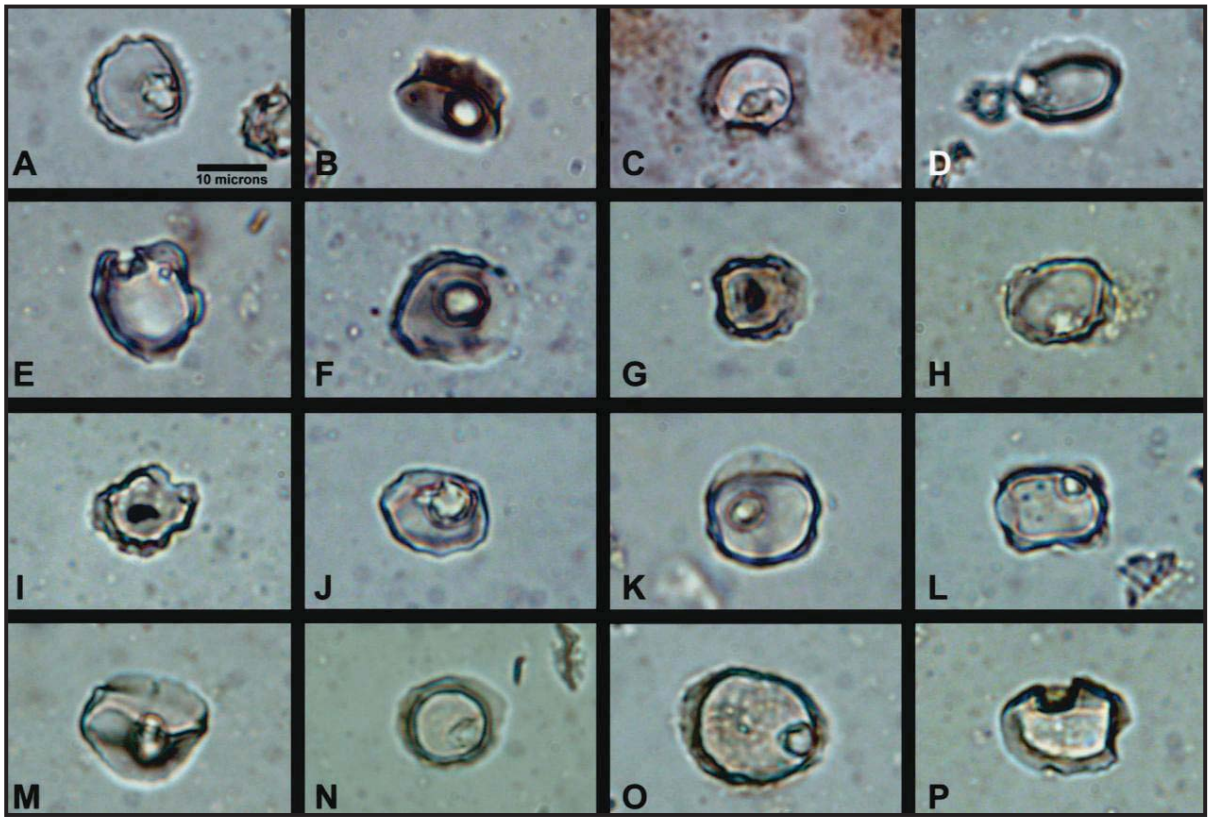

Figure B-26. Large disk-shape or rondel phytoliths; possible *Zea mays* phytoliths.
A (sample 1, pithouse 1), B (sample 4, basin heating element, Feature 8), C-E (sample 6, heating element, Feature 11), F (sample 8, ashy stain), G-I (sample 10, basin heating element, Feature 5), J (sample 12, top of floor in pithouse 2, Feature 6), K (sample 14, eolian on top of pithouse 2, Feature 6), L-M (sample 18, earthen construction fill in pithouse 2, Feature 6), N-O (sample 19, floor of pithouse 2, Feature 6), and P (sample 21, basin heating element, Feature 16).

specimens are pristine cucurbit specimens compared to Figure B-30A. The specimens in Figure B-30H, L, N, O, and possibly R appear to be somewhat flattened (i.e., not spherical) which likely excludes them from being classified as cucurbit phytoliths. In Figure B-29I, R, and T may be cucurbit phytoliths; appearance and potential preservation issues make it impossible to tell for certain; thus, the question of phytolith evidence for cucurbits at the site currently remains unanswered.

Obsidian debitage can be included in phytolith preparations (Sudbury 2011b:18). Some small micro-chips or micro-flakes were prepared by jostling thin-edged obsidian flakes together in a Ziploc bag; three of the resulting modern obsidian fragments are shown in Figure B-31A through B-31C; visible conchoidal fractures were generally not produced by this method. The specimens in Figure B-31D through I were recovered from the construction fill above the floor of pithouse 2. Specimens D, H, and I are felt to be phytoliths. The very large odd specimen (G) and the smaller specimen with trace evidence of conchoidal fracture (F) are felt to be obsidian microchips or flakes generated during the site occupation. The specimen shown in B-31E is indeterminate. An important consideration is that in areas and eras with volcanic activity (or if redeposition of volcanic debris occurs onto the site)—one cannot visually distinguish between volcanic ash particles and obsidian micro-chips.

No complete spicules or gemmoscleres were observed. The recovered spicule fragments are all illustrated in Figure B-32. Specimens varied from pristine (Figure B-32A) to very heavily weathered Figures B-32K and B-32L (and everything in between). A few statospores were observed while processing these soil samples. Also, a crystalline material with low birefringence and a variety of crystal habits in was observed in most of these soil samples; an effort to identify this material and its significance is ongoing (an example of the hexagonal habit is in see Figure B-17D2 and B-17D3). A small number of the unidentified particles observed in this study that were recovered from the two pithouse floors are illustrated in Figures B-33 through B-34.

B.4 Discussion

B.4.1 Agriculture—Corn, Beans, and Squash: Images of phytoliths representing these three major crops are in the literature.

Corn or maize (*Zea mays*) phytoliths are present in these samples from both cobs (see Figure B-27) and from leaves (see Figure B-28) (Pearsall 1978; Pearsall, Chandler-Ezell, and Chandler-Ezell 2003; Piperno 2006:45-65, 200-204). Distribution data of the large variant 1 cross bodies (which indicate maize leaves) at the site is in Tables B-3 through B-6. That data, along with incidence of burned cross body phytoliths (see Table B-7), is briefly discussed in the following subsections.

Beans (*Phaseolus* sp.) are generally most easily recognized by their silicified plant hair cells (Bozarth 1986:58, 64; Bozarth 1990:100). No phytolith evidence of beans was observed in the soil samples analyzed from 41RB112.

Cucurbits produce distinctive large scallop-surfaced roughly spherical phytoliths (Bozarth 1986:58, 60, 65 through 66; Bozarth 1987; Piperno 2006:65-71, 205-206). A number of candidate particles were observed in these samples (see Figure B-29, phytoliths from a reference botanical specimen are in Figure B-30). In addition to some phytoliths in Figure B-29 being undersized, the larger specimens generally do not have the optimal expected surface appearance (i.e., see Figure B-30A). Those issues, coupled with the confounding issue of the variable and at times heavy phytolith weathering/dissolution problem (Figure B-13), renders positive identification of any of these specimens as cucurbit phytoliths impossible. Bozarth (1987:611) notes that some phytoliths in his cucurbit reference collection were less distinctive due to their shallow scallops. He also noted significant variation in size and degrees of silicification based on environmental factors (ibid. 612). Piperno (2006:67-69) indicates that cucurbits from domesticated plants are much larger than those from wild plants. It is possible that some if not all of the larger phytoliths in Figure B-29 are actually bulliform phytoliths with heavy edge weathering—or some or all may be cucurbit phytoliths. Positive identification of

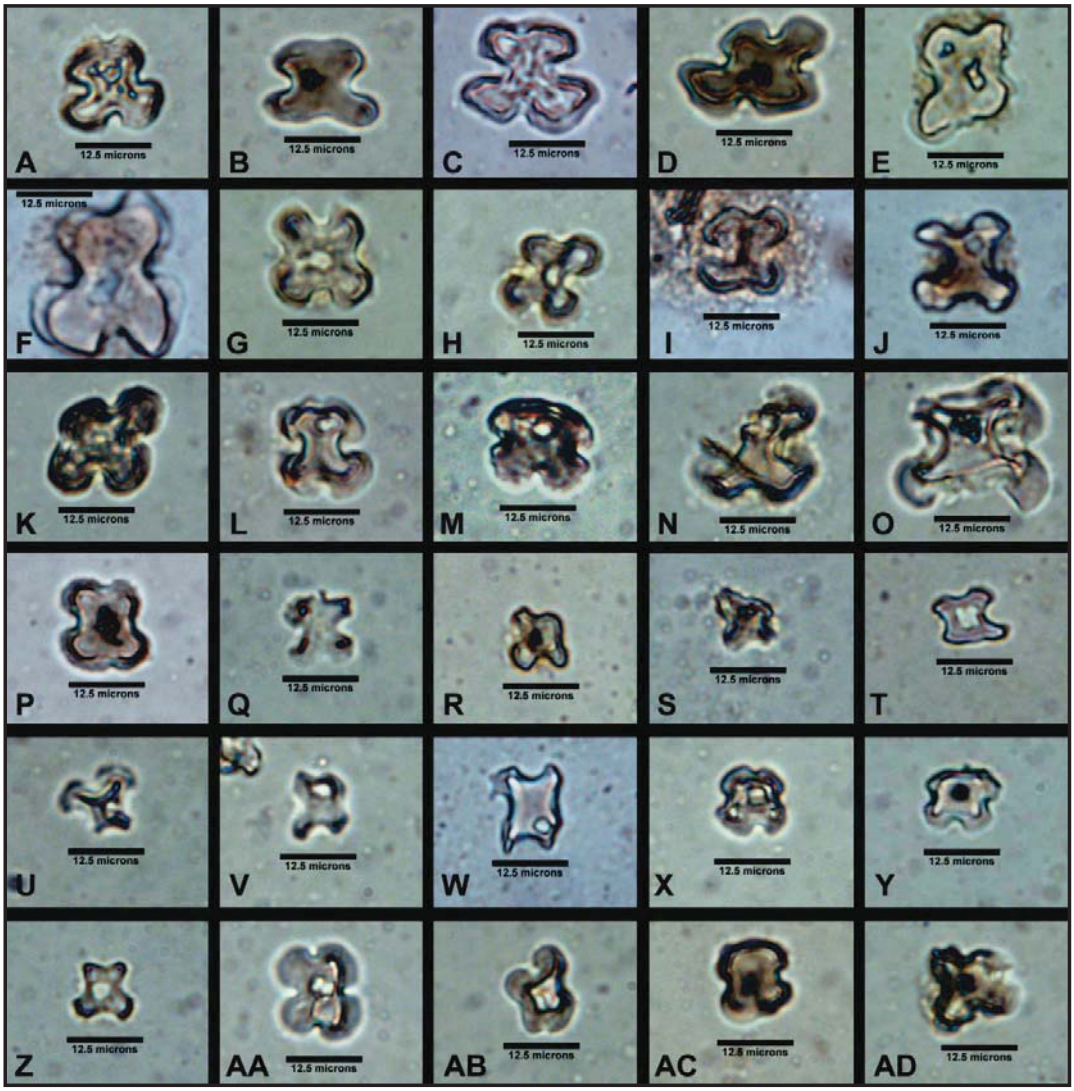

Figure B-27. Representative cross-shaped phytoliths from the bottom of the basin heating element Feature 5 (sample 10).

The specimens wider than 12.57 microns (Specimens A through O) are likely from *Zea mays* whereas those narrower than 12.57 microns are felt to be crosses from non-*Zea Poaceae* sources (i.e., non-domesticated native grasses (specimens P through AD; with P being on the borderline between the two size categories). All images are the same scale; the scale bar is 12.5 microns. Specimens B, D, K, M, P, S, AC and AD are heavily burned; specimens A, G through J, L, N, O, Q through S, X, and AB appear to be lightly charred. Images taken during rescan of entire slide looking for morphological forms of interest.

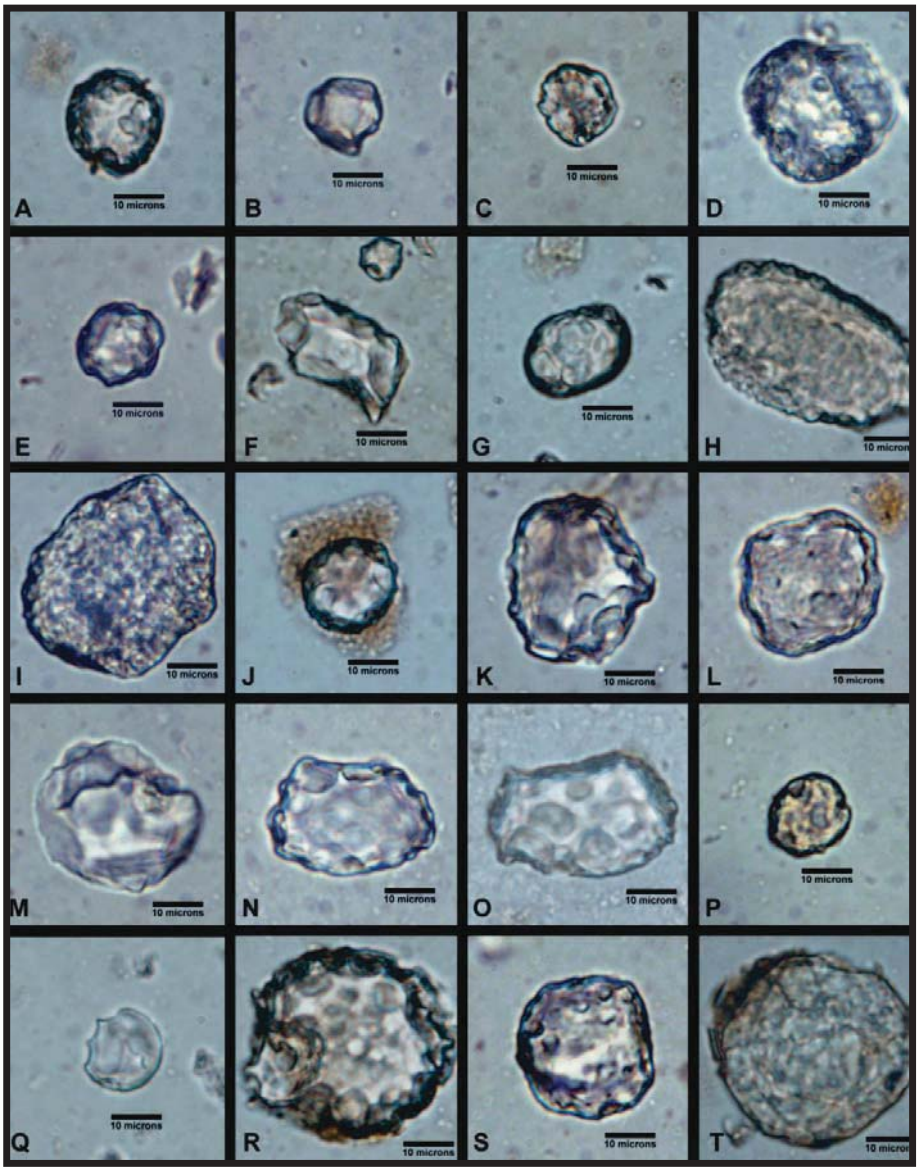

Figure B-28. Phytoliths bearing some features similar to those of cucurbit phytoliths. A and B: Sample 1 (based of pithouse 1); C: Sample 2 (wall profile, floor of pithouse 2, Feature 6); D: Sample 3 (floor of pithouse 1); E: Sample 5 (southwest part of broad heating element, Feature 10); F: Sample 9 (lower part of thickened A horizon in shallow swale between Component A and Component C (control)); G through H: Sample 10 (pithouse 2 floor, Feature 6), I: Sample 12 (lower portion of construction fill on top of pithouse 2 floor); J: Sample 13 (north wall profile inside and on floor of pithouse 2); K through M: Sample 15 (middle of earthen construction fill inside pithouse 2, western side); N: Sample 16 (upper part of pithouse 2 floor below earthen construction fill, western side); O: Sample 17 (bottom of pithouse 2 floor, western side); P through Q: Sample 19 (pithouse 2 floor, upper, near center of pithouse); R: Sample 20 (pithouse 2 floor, near center of pithouse); S: Sample 21 (bottom of basin heating element Feature 16 with burned maize cobs); and T: Sample 25 (control surface soil).

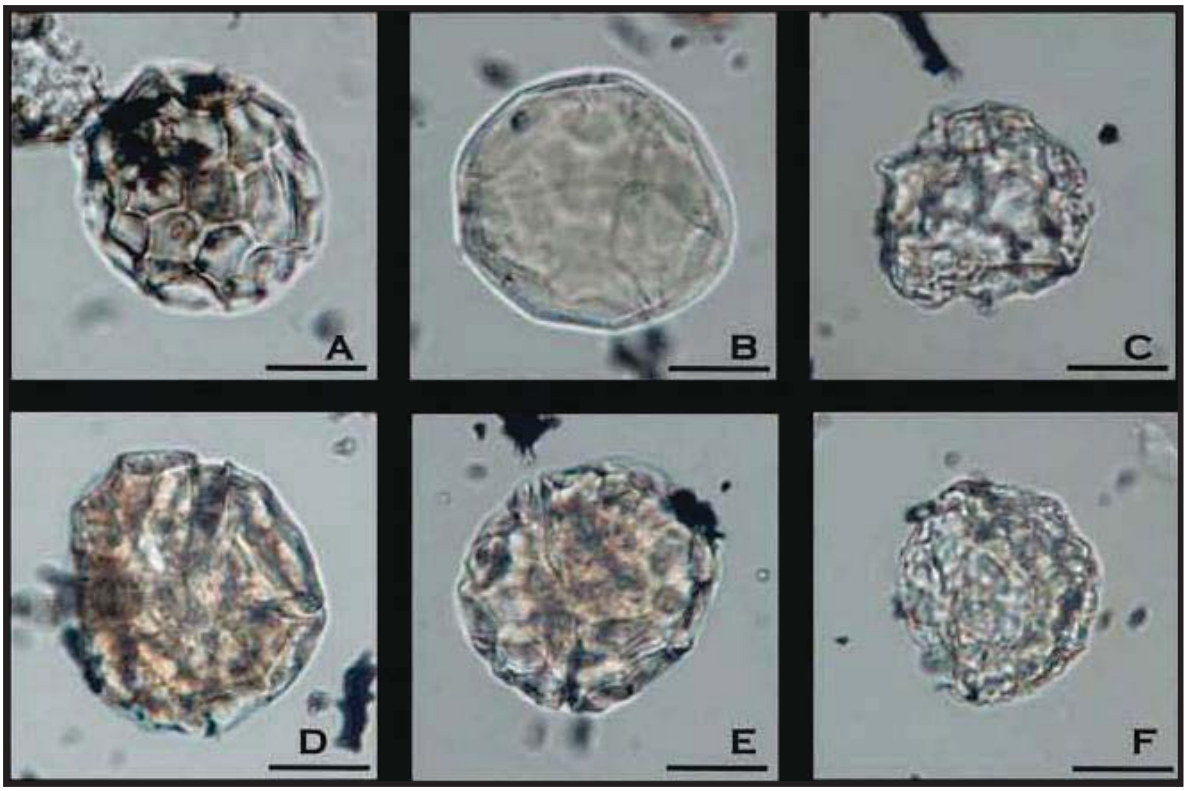

Figure B-29. Variety of phytoliths recovered from Buffalo Gourd (*Cucurbita foetidissima kunth*) reference specimen (Sudbury 2007:35).
Bar scales are 10 microns.

cucurbits at 41RB112 is not currently possible from the available phytolith record.

Starch analysis was not performed on these samples.

B.4.2 Off-Site Surface Control Soil (sample 25: soil in pristine prairie on south side of Canadian River)

B.4.2.1 Surface Soil Burned Phytolith Incidence

The only burned short cell phytolith type present in the off-site surface control soil sample was the warm moist panicoid lobate variety at a 16.7 percent burned phytolith specimen incidence (see Table B-7, sample 25). As any panicoid (the major Poaceae biomass) from the prior growing season would be a potential fuel source, it is probable that this burned phytolith value represents an approximation of the site area's environmental background fire incidence. This background fire value would not be expected to necessarily carry over to specific habitation features which would be strongly influenced by human activity.

B.4.2.2 Surface Soil Seasonality Profile

The phytolith signature is predominantly hot dry weather chloridoid phytoliths (Table B-8; see Figure B-11). The signature is very similar to that of bottom of heating element Feature 20 with burned maize cobs (sample 22), and similar to the on-site control (sample 9).

Phytolith seasonality data from modern soils at several area upland sites is shown for comparative purposes (Table B-8 [data from Beaver and Roger Mills Counties, Oklahoma Sudbury 2011b:120]). The Bull Creek site (34BV176), an upland shortgrass prairie (SG), is far removed from water,

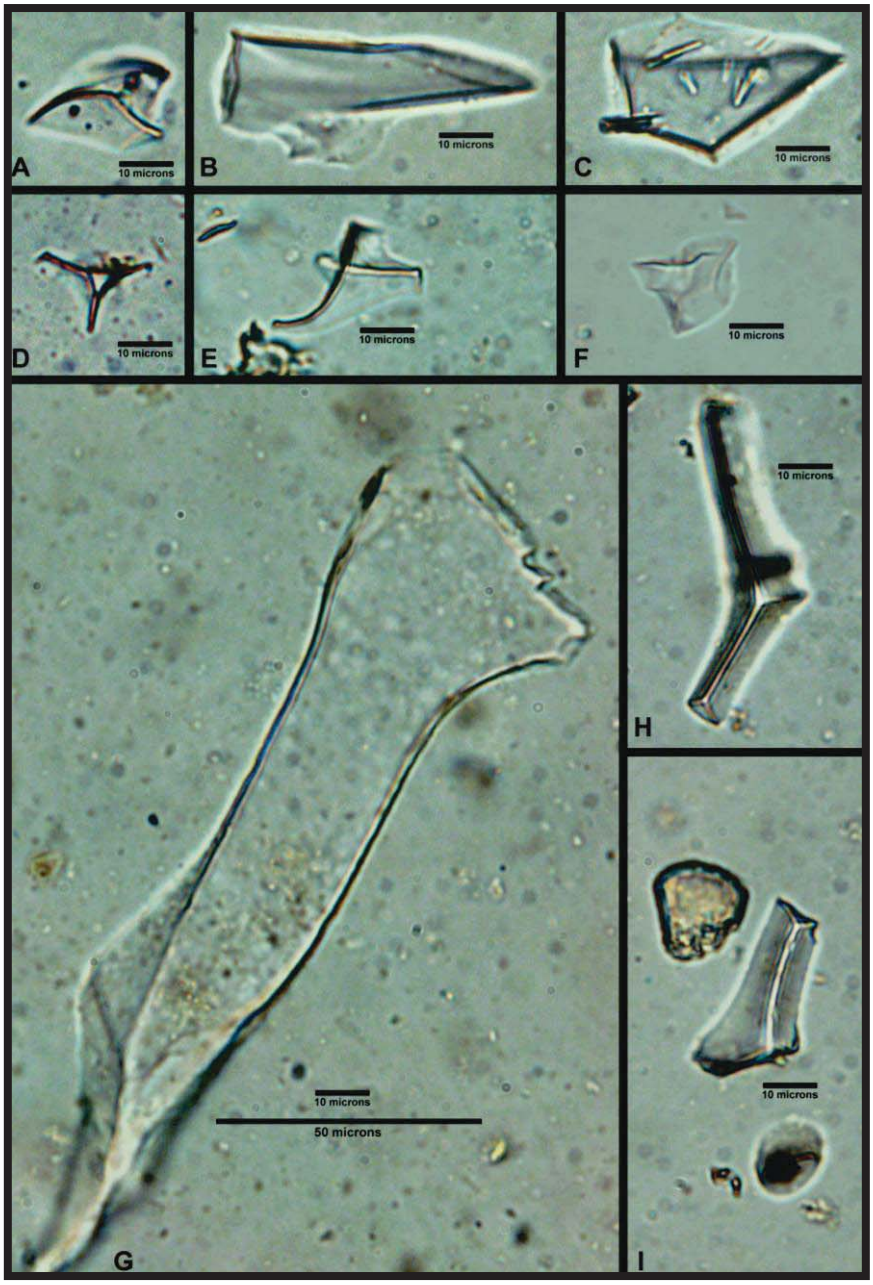

Figure B-30. Other amorphous particles (obsidian).

A through C: Obsidian micro-flakes produced in the lab for comparative analysis. D through I: specimens observed in the phytolith isolate from lowest part of construction fill above the floor of pithouse 2, Feature 6 (Sample 12). D, H, and I appear to be of plant origin (I also contains a bulliform phytolith (above) and a keeled phytolith (below)). F and G are felt to be obsidian micro-flakes; F shows traces of conchoidal fracture, and G is very large and unlike any plant material that I have previously encountered. The originating source of specimen E is indeterminate.

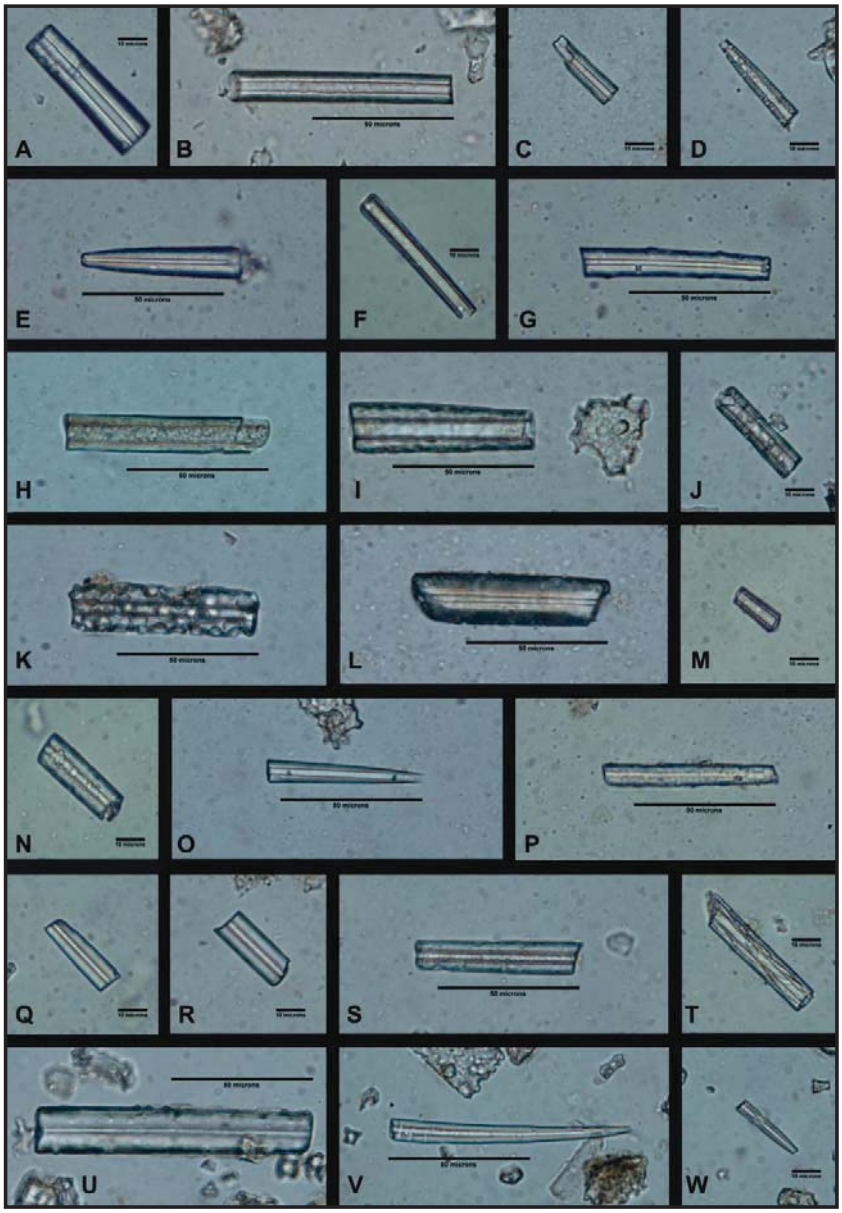

Figure B-31. Sponge spicule sections from the Long View site.

A and B: sample 1 (from cutbank profile, base of pithouse 1); C: sample 4 (inside west half of small basin heating element); D and E: sample 6 (inside heating element); F and G: sample 7 (bottom of small storage pit); H: sample 8 (ashy stain next to heating element Feature 10); I: sample 9 (lower part of thickened A horizon in swale between Components A and C); J: sample 14 (upper end of eolian fill on top of construction fill towards western side of pithouse 2); K: sample 13 (north wall profile inside and on floor of pithouse 2); L: sample 16 (upper part of pithouse 2 floor below earthen construction fill, western side); M through O: sample 15 (middle of earthen construction fill inside pithouse 2, western side); P and Q: sample 18 (earthen construction fill near center of pithouse 2); R: sample 19 (pithouse floor, upper, near center of pithouse 2); S and T: sample 20 (pithouse floor near center of pithouse 2); and U through W: sample 25 (off-site surface control).

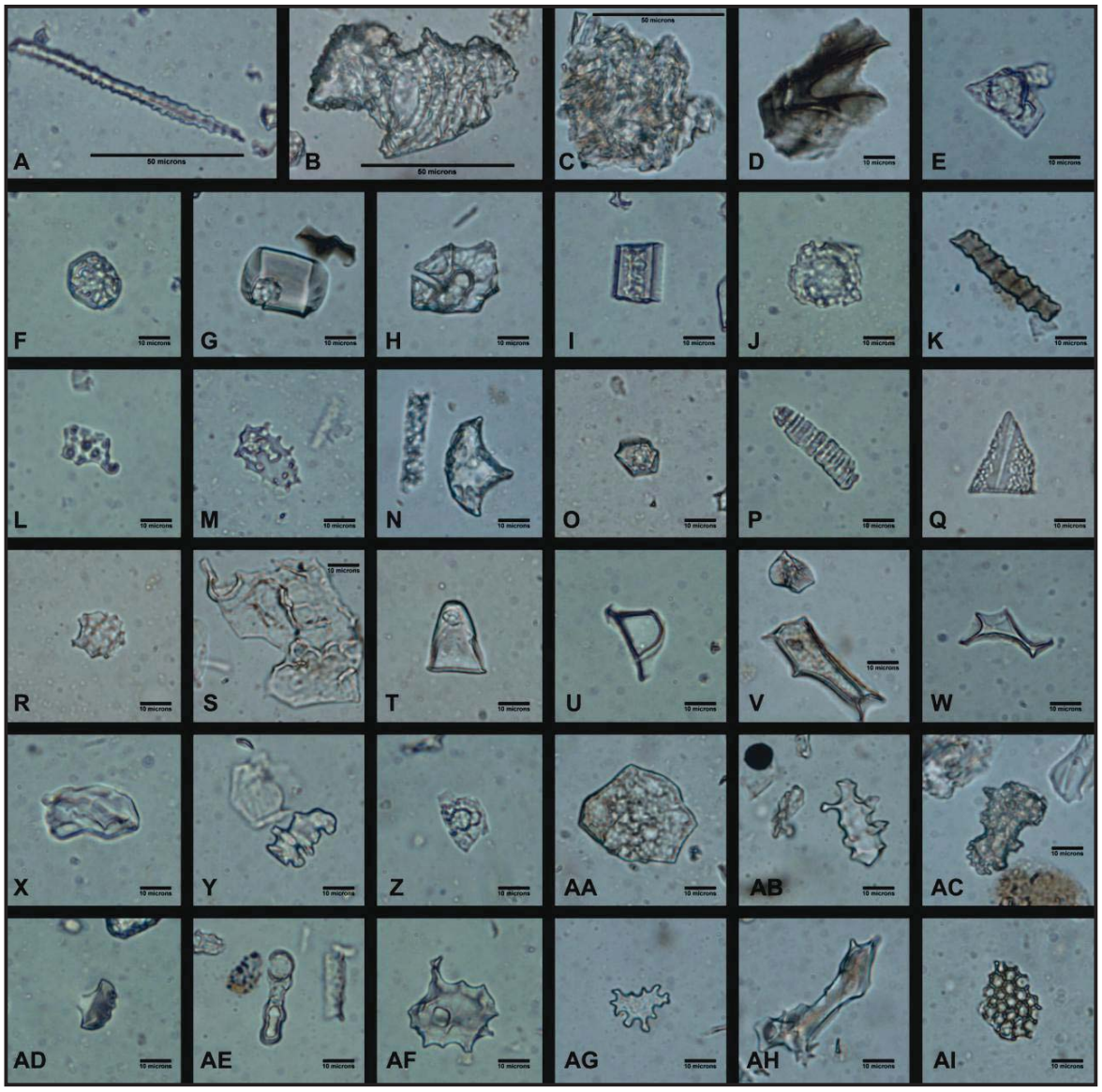

Figure B-32. Other representative miscellaneous amorphous particles recovered from the floor of pithouse 1.

A through F and H through M: sample 1 (from cutbank profile, base of pithouse 1); O through X: sample 2 (from profile wall, floor of pithouse 1); and G and Z through AI: sample 3 (from floor of pithouse 1). Specimen N is a bulliform phytolith, and specimens V and W are likely phytoliths of tree origin.

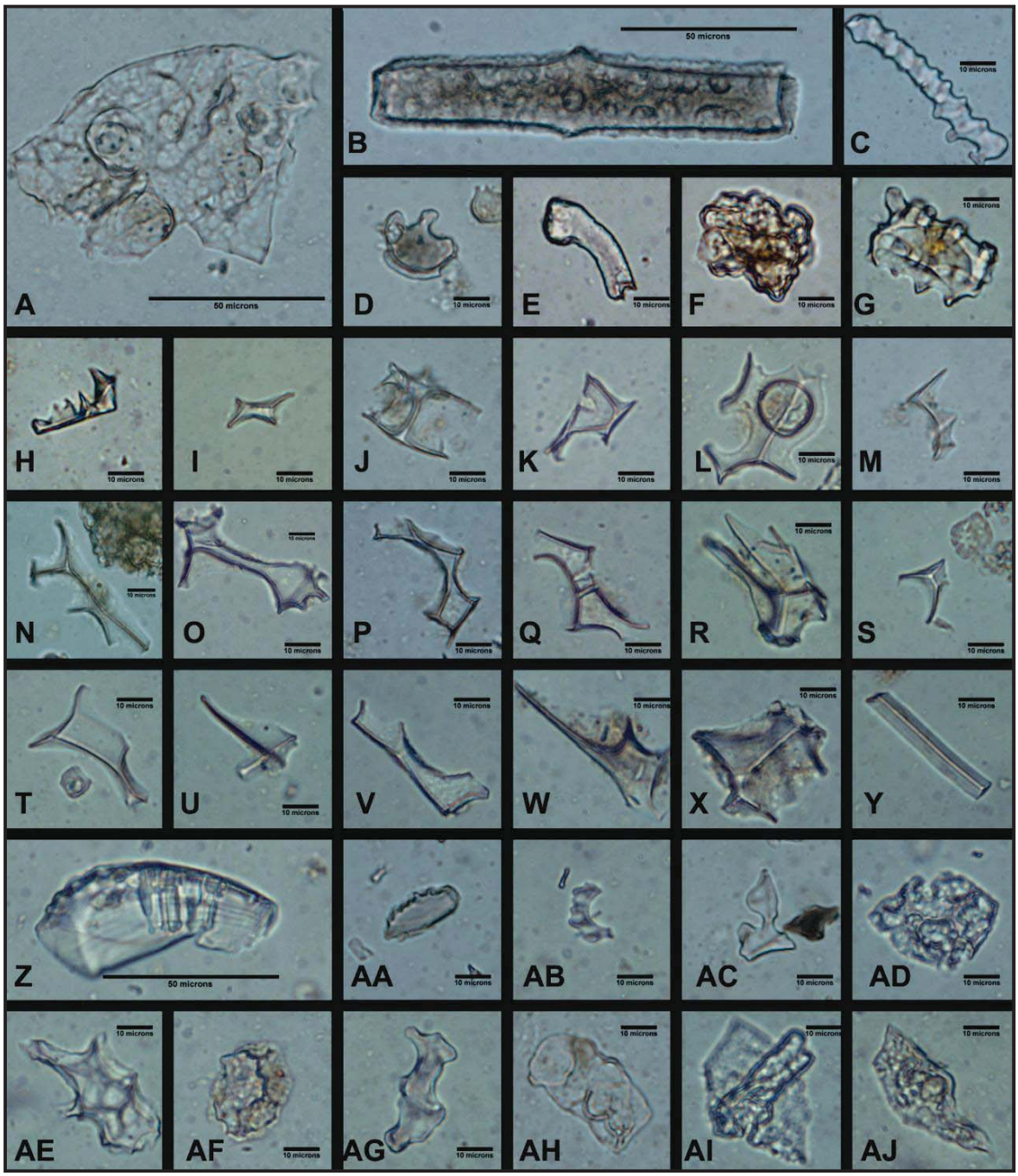

Figure B-33. Other representative miscellaneous amorphous particles recovered from the floor of pithouse 2.

A through Y: sample 20 (pithouse floor near center of pithouse 2); Z through AD: sample 11 (pithouse 2 floor); AE through AG: sample 16 (upper part of pithouse 2 floor below earthen construction fill, western side); and AH through AJ: sample 17 (bottom of pithouse 2 floor, western side). All specimens are amorphous; Z could conceivably be obsidian; the remaining specimens are all thought to be phytoliths. Specimens I through X are likely blocky forms associated with trees. All of these specimens have information potential—once their botanical origin is identified.

so it is not directly comparable to the current 41RB112 setting, and the phytolith seasonality data does not match. Although also an upland setting, the mixedgrass prairie (MG) phytolith seasonality signature for Dempsey Divide is similar to that obtained at 41RB112. The difference in phytolith signatures between upland and alluvial settings in the same prairie area has been addressed (Sudbury 2011b:179-187).

B.4.3 Component A - Pithouse 1 and Associated Features:

soil sample 1: from cutbank profile, base of pithouse 1
soil sample 2: from profile wall, floor of pithouse 1
soil sample 3: from floor of pithouse 1
soil sample 4: inside west half of small basin heating element, Feature 8
soil sample 5: southwest part of broad heating element, Feature 10
soil sample 6: inside heating element, Feature 11
soil sample 7: bottom of small storage pit, Feature 13
soil sample 8: ashy stain next to heating element Feature 10

B.4.3.1 Pithouse 1 Soil Seasonality Profile

The phytolith signatures of two of the three pithouse floor samples (samples 1 and 2) are remarkably similar. The other pithouse floor sample (sample 3) shares the same cool season pooid concentration, but has higher hot dry chloridoid and lower warm moist panicoid concentrations; the phytoliths assemblage of one pithouse floor sample (sample 3) is more similar to the on-site control (sample 9; see Figure B-11). The actual phytolith signatures of the three basin heating elements (samples 4, 5, and 6) are different with heating element 11 (sample 6) and storage pit Feature 13 (sample 7) being most similar (see Figure B-11). Heating element Feature 8 (sample 4) had a high hot dry chloridoid content and low warm moist panicoid content, whereas the three seasonality forms are roughly equal in heating element Feature 10 (sample 5). In heating element Feature 11 (sample 6), the pooid content was elevated at the expense of the panicoid concentration. The cool season pooid concentration was uniform in heating elements 8 and 10 (samples 4 and 5), whereas heating elements 10 and 11 (samples 5 and 6) exhibited relatively constant hot dry chloridoid concentrations. The ashy stain (sample 8) is generally dissimilar from the other samples in Component A. If the grasses used in this area were being gathered as fuel, they would be collected once dried (i.e., off-season). However, if the grasses were gathered for food use or other applications they would likely be gathered near the end of the growing season.

B.4.3.2 Pithouse 1 Burned Phytolith Incidence

The composition of two of the three pithouse samples' burned phytolith short cell signatures (samples 1 and 3) are very similar, likely indicating a similar activity area whereas that of sample 2 is different (Table B-9). Sample 2 also had a higher phytolith concentration (see Table B-2), less charcoal, and fewer bulliform phytoliths than the other two samples (see Table B-3). However, sample 2's short cell phytolith seasonality signature was very similar to sample 1, whereas sample 3 had a higher hot dry chloridoid component (seasonal difference, i.e., hot dry weather, or different targeted biomass collection source) at the expense of the warm moist panicoids (see Figure B-7). The

Table B-8. Normalized Percent Short Cell Phytoliths in Seasonality Groupings (ibid.).

	41RB112	Bull Creek SG	Dempsey Divide MG
Pooids	30.60%	10.10%	26.80%
Chloridoids	62.90%	82.20%	66.70%
Panicoids	6.50%	7.70%	6.40%

noticeably high burned small panicoid cross content observed in samples 1 and 3 may be associated with specific processing activities (Table B-9).

Interestingly, the only burned phytolith form in this area's basin heating elements was the tall saddle form of hot and dry chloridoid phytoliths; the same form was also the only one observed in the related storage pit but at a much higher normalized concentration (Table B-10). No burned warm moist panicoid phytoliths were observed in the storage pit or heating elements although they were relatively concentrated in soil samples 1 and 3. In the ashy stain from Component A (sample 8), a variety of burned phytolith forms were present (Table B-11). The forms in sample 8 appear to be a blend of what was observed in samples 1 through 3 (see Table B-9) with an additional form (*Stipa*) also being present.

B.4.3.3 Pithouse 1 Food Processing (maize, beans, cucurbits)

Large warm moist panicoid cross-bodies indicative of maize were observed in the formal particle counts for all samples in Component A except for the storage pit Feature 13 (sample 7; see Tables B-3 and B-4). One broken charred maize kernel was also recovered (see Figure B-7). No absolute definitive evidence of Phaseolus or Cucurbits was observed. The variations in burned phytolith incidence (see Tables B-9 though B-11) may be indicative of variations in activity areas, food processing, and/or season of use (i.e., tinder-gathering of available dry biomass).

B.4.4 Component B - Swale between Components A and C (On-site Control sample 9: lower part of thickened A horizon, in shallow swale)

B.4.4.1 On-site Control Soil Seasonality Signature and Burned Phytolith Incidence:

This on-site control soil had a relatively elevated bulliform component, and also shows evidence of extensive bulliform weathering (see prior discussion in the data section and see Figure B-13E and B-13F) which indicates the likelihood of some phytolith preservation/dissolution issues in the area and at the site. This sample's charcoal content is also somewhat elevated (see Table B-4)—especially compared to the off-site control sample (sample 25; see Table B-6). No burned short cell phytoliths were observed in the formal scans of this phytolith isolate (see Table B-11). This sample's climatic signature (see Figure B-7) is generally most similar to the floor of pithouse 1 (sample 3), bottom of heating element with burned maize cobs, Feature 20 (sample 22), and off-site control soil (sample 25).

B.4.5 Component C - Pithouse 2 Feature 6 and Associated Features:

soil sample 10: bottom of basin heating element Feature 5
soil sample 11: pithouse 2 floor
soil sample 12: lower portion of construction fill on top of floor
soil sample 13: north wall profile inside and on floor of pithouse 2
soil sample 14: upper end of eolian fill on top of construction fill towards western side of pithouse 2
soil sample 15: middle of earthen construction fill inside pithouse 2, western side
soil sample 16: upper part of pithouse 2 floor below earthen construction fill, western side,

soil sample 17: bottom of pithouse 2 floor, western side
soil sample 18: earthen construction fill near center of pithouse 2
soil sample 19: pithouse floor, upper, near center of pithouse 2
soil sample 20: pithouse floor near center of pithouse 2
soil sample 21: bottom of basin heating element with burned maize cobs, Feature 16
soil sample 22: bottom of heating element with burned maize cobs, Feature 20 soil sample 23: inside, bottom of storage pit, Feature 23
soil sample 24: ashy stain on floor of pithouse 2, Feature 6 eastern end

B.4.5.1 Pithouse 2 Soil Seasonality Profile

The most striking thing about the set of ten pithouse samples (soil samples 11 through 20, Tables B-12 and B-13) from Component C is the very high

Table B-9. Component A Pithouse 1 Floor Samples—Percent Burned Short Cell Phytolith Morphotypes.

Soil Sample Number	1 [F1]	2 [F1]	3 [F1]
Field Sample Number	1278-4-1a	1164-4-11a	1164-4-7a
Percent Burned			
Keeled			
Conical		7.7	
Pyramidal			
Crenate			
Saddle, squat			
Saddle, tall	1.2		2
Stipa			
Lobate, Simple			
Lobate, Panicoid	12.5	6.7	5.9
Lobate, Panicoid (compound)			
Cross, Panicoid (<12 μ)	50		33.3
Cross, Panicoid (>12 μ)			

Table B-10. Component A Basin Heating Elements (Features 8, 10, and 11) and Storage Pit (Feature 13)—Percent Burned Short Cell Phytolith Morphotypes.

Soil Sample Number	4 [F8]	5 [F10]	6 [F11]		7 [F13]
Field Sample Number	1116-4-1a	1080-4-1a	1032-4-1c		1023-4-2b
Percent Burned					
Keeled					
Conical					
Pyramidal					
Crenate					
Saddle, squat					
Saddle, tall	4	16.7	1.8		58.3
Stipa					
Lobate, Simple					
Lobate, Panicoid					
Lobate, Panicoid (cmpd)					
Cross, Panicoid (<12 μ)					
Cross, Panicoid (>12 μ)					

Table B-11. Unidentified Function Feature from Component A—Percent Burned Short Cell Phytolith Morphotypes (Sample 8), and Component B—Percent Burned Short Cell Phytolith Morphotypes (Sample 9).

Soil Sample Number	8 [-]	9 [-]
Field Sample Number	1128-4-1a	77-4-1a
Percent Burned		
Keeled		
Conical	8.7	
Pyramidal		
Crenate		
Saddle, squat		
Saddle, tall		
Stipa	20	
Lobate, Simple		
Lobate, Panicoid	20.4	
Lobate, Panicoid (compound)		
Cross, Panicoid (<12 µ)	33.3	
Cross, Panicoid (>12 µ)		

cool season pooid content in floor of the pithouse (sample 17, with no panicoids present at all (see Figure B-11). Likewise interesting, eolian fill on top (sample 14) has a very low warm moist panicoid content although the hot dry chloridoid and cool pooid components are somewhat more balanced. The next lowest panicoid content was observed in north wall of pithouse next to floor (sample 13) and then the pithouse floor (sample 11). Conversely the panicoid content was relatively high in earthen construction fill and on the floor (samples 15, 18, and 20). This variation in distribution would likely require active intentional plant gathering and/or specific activity areas within the structure, and/or could potentially reflect changing seasons during occupation as alternate resources came into use. Contributing to the difficultly in interpreting these large concentration jumps is knowing whether the botanicals were being gathered dry for use as fuel, near the end of the growing season as a food resource, or for various other applications.

The two outside heating elements, Features 16 and 20 (samples 21 and 22) have elevated hot dry chloridoid concentrations and very low warm moist Panicoid concentrations while the storage pit (sample 23) has the lowest chloridoid concentration observed in this sample suite (see Figure B-11) and the second highest cool season pooid content. All of these assemblage variations presumably indicate different activity areas and/or processing activities as well as possible seasonal variations. Interestingly, the phytolith seasonality signature of bottom of heating element with burned maize cobs, Feature 20 (sample 22) and the control soil (sample 25) are practically identical (see Figure B-11).

B.4.5.2 Pithouse 2 Burned Phytolith Incidence

Another striking point is the very high percent of burned specimens of some phytolith forms—for instance the burned frequencies of *Stipa* and simple lobate in the north wall profile inside and on floor of the pithouse (sample 13) were 100 percent (Table B-12). The concentration of burned crosses in the pithouse floor, lower part of the construction fill, and north wall next to floor (samples 11, 12, and

14) is also fairly high (Tables B-12 and B-13). At the other end of the spectrum, there were no burned phytoliths observed in the middle of the earthen construction fill and the western side of the pithouse floor (samples 15 and 17). The western side of the pithouse floor (sample 17) as pointed out above as being anomalous due to the very high pooid content—indicating that they gathered cool season botanicals, but interestingly no pooids show up as burned (also, this sample had a low total short cell count [possible phytolith preservation issues]). The lower part of the construction fill and of the earthen construction fill near the center of the pithouse (samples 12 and 18) have a large variety of burned short cell forms and are the only two samples besides that from the bottom of the basin heating element of Feature 5 (sample 10) which produced both large (maize) and small (wild Poaceae) burned panicoid cross bodies.

In looking at the associated features in Component C, Feature 5 basin heating element (sample 10) has the most different burned phytolith short cell forms of any soil sample evaluated in this study including three of four cool pooid forms and four of the five warm moist panicoid forms (Table B-13). It also has a relatively elevated panicoid concentration that looks similar to middle of the earthen construction fill on the western side (sample 15, see Figure B-11). This has a lower variety of burned forms but has the highest burned simple lobate panicoid concentration observed in these samples except for the north wall near the floor (sample 13). The storage pit Feature 23, (sample 23) only contained burned conical phytoliths whereas the heating element Feature 20 (sample 22), joins the site's control sample (sample 9), the earthen construction fill on the western side (sample 15), and the floor on the western side of the pithouse (sample 17) in having no burned phytoliths present.

In contrasting Components A and C, 6 out of 8 (75 percent) samples from Component A have burned hot dry chloridoid forms (at low concentrations), whereas only 2 out of 13 (15 percent) samples from Component C have burned hot dry chloridoid phytoliths.

B.4.5.3 Pithouse 2 Food Processing (maize, beans, cucurbits)

Maize cross-bodies were observed in 11 out of 15 soil sample phytolith counts (see Tables B-4 through B-6) or 73 percent of the pithouse 2 samples versus 88 percent of the pithouse 1 samples. However, the formal particle counts of the pithouse 2 samples showed burned maize cross-bodies in four soil samples from pithouse 2 (see Tables B-12 and B-13) versus none in pithouse 1 (see Tables B-9 through B-11). The crosses in Figure B-22 are all from the bottom of a heating element Feature 5 (sample 10), which also had the highest large cross phytolith count at the site (see Tables B-3 through B-6), and which also had the greatest variety of burned phytolith forms encountered (see Table B-13). No cucurbit phytoliths were positively identified, and no bean silicified hair cells were observed.

B.4.6 Phytolith preservation

Phytolith preservation (due to dissolution) was apparently poor in some 41RB112 samples (see prior discussions regarding bulliform phytoliths, relatively low short cell counts, and potential soil pH-related phytolith dissolution). In the past, while processing basic soils with high charcoal concentration, apparent phytolith preservation problems were observed (Sudbury 2007:16-18, 23-24). One theory regarding a mechanism whereby this may occur is related to aluminum's stabilizing/protective effect on phytoliths; when charcoal lowers the soil aluminum concentration in the vicinity of phytoliths; the phytoliths lose that protective function and become more susceptible to dissolution (ibid.). The presence of carbonates in the soil profile at 41RB112 indicates a basic pH which is one potential reason that variation in the bulliform: short cell count ratio occurred across the site (i.e., due to selective more rapid dissolution of the smaller short cell phytoliths).

B.5 Summary

B.5.1 Controls

The off-site control (sample 25) and on-site control (sample 9) have somewhat similar seasonality profiles based on short cell morphotypes, while

Table B-12. Feature 6 (Pithouse 2 floor) Percent Burned Short Cell Phytolith Morphotypes.

Soil Sample No.	11	13	16	17	20
Field Sample Number	1284-4-1a	139-4-1a	C-3 Zone 5 Spl 17	C-3 Zone 5 Spl 18	C-7 Zone 5 Spl 10
Percent Burned:					
Keeled					
Conical	2.9				
Pyramidal					
Crenate					
Saddle, squat					
Saddle, tall					2.8
Stipa		100			
Lobate, Simple		100			
Lobate, Panicoid	15.2		10		14.5
Lobate, Pan'd (cmpd)					
Cross, Pan'd (<12 μ)	50				14.3
Cross, Pan'd (>12 μ)					

Table B-13. Feature 6 (Pithouse 2) Construction Fill, Percent Burned Short Cell Phytolith Morphotypes.

Soil Sample No.	12	14	15	18	19
Field Sample Number	1282-4-1a	C-3 Zone 3 Spl 6	C-3 Zone 4 Spl 14	C-7 Zone 7 Spl 8	C-7 Zone 9 Spl 9
Percent Burned:					
Keeled				4.8	
Conical					2.9
Pyramidal	5			6.7	
Crenate					
Saddle, squat					2.4
Saddle, tall					
Stipa					11.1
Lobate, Simple	25				
Lobate, Panicoid	14.8			3.4	11.6
Lobate, Pan'd (cmpd)					
Cross, Pan'd (<12 μ)	33.3	100		14.3	11.8
Cross, Pan'd (>12 μ)	33.3				5.9

the seasonality signature of the bottom of a heating element Feature 20 (sample 22) is even more similar to the off-site control (sample 25, see Figure B-7). In addition to slight difference in subfamily seasonality group concentrations, these three soil samples vary noticeably in their burned phytolith component content. The on-site control (sample 9) and Feature 20 (sample 22) had no burned phytoliths while off-site control sample (sample 25) had a low rate of burned panicoid phytoliths (16.7 percent, see Table B-7).

B.5.2 Comparison of Pithouse 1 and Pithouse 2

Burned tall saddle phytoliths are present in 6 of 8 pithouse 1 samples. For the three pithouse floor samples, the seasonality signature of samples 1 and 2 is most similar, whereas the burned phytolith signature (suggesting similar activity) was most similar for samples 1 and 3. The greatest variety of burned phytoliths is in sample 8 (the ashy stain next to a heating element). The three pithouse floor samples have a strong chloridoid signature averaging 55.6 percent chloridoid (see Table B-3) with sample 3 being the highest individual value of the set. Heating element Feature 5 (samples 6) and storage pit Feature 13 (sample 7) show a stronger Pooid signature while the southwest part of broad heating element Feature 10 (sample 5) has the highest panicoid component observed in pithouse 1.

The sample suit from pithouse 2 is more complex (see Tables B-4 through B-6 and B-12 through B-16). The two floor-related samples 11 and 13 have very similar seasonality signatures (see Tables B-4 and B-5) but dissimilar burned phytolith signatures (see Table B-12). The bottom of the pithouse floor (sample 17) has zero panicoid component [and no burned phytoliths], whereas the soil sample near the center of the pithouse (sample 20) has the highest panicoid content of any floor sample (1, 2, 3, 11, 13, 16, 17, and 20). The bulliform cell short cell ratio is elevated for samples 13 (north wall profile inside and on floor of pithouse), 16 (upper part of pithouse floor below earthen construction fill, western end), and 17 bottom of pithouse floor, western side), and to a lesser extent 11 (pithouse floor) (Table B-15) suggesting the likelihood of enhanced dissolution of short cell phytoliths in those areas.

Two of the construction fill/roof debris, the lower portion of construction fill on top of floor (sample 12) and the middle of earthen construction fill inside pithouse, western side (samples 15) also have elevated relative bulliform counts (Table B-16). Water collecting in and percolating through the structure post abandonment would potentially have a negative impact on phytolith preservation. In addition to basic soil pH from the underlying Ogallala formation, ash deposits in the structure could also contribute to the detrimental pH impact on phytolith preservation posthabitation.

The higher relative warm moist panicoid concentration in the roof debris/fill (samples 15 and 18, and to a lesser extent 12 and 19) likely indicates incorporation of panicoid plants in roof construction. Panicoid plants have a significantly greater biomass than the chloridoid plants making panicoids more suitable for use in construction and roofing. The equally high panicoid concentration in the pithouse floor near center of pithouse (sample 20) may be residual from roof fall debris sloughing off and moving into that zone. This localized higher central panicoid concentration support's the geoarcheologist's central smoke hole interpretation.

In contrast to the phytolith preservation issues encountered in some feature samples, the phytolith preservation in the eolian sample covering pithouse 1 is good (see Table B-16) and matches that of the off-site control soil sample 25. Both samples have similar low warm moist panicoid content, and an elevated hot dry chloridoid content. The cool pooid content in the eolian deposit over the pithouse (sample 14) is higher than that of the off-site control (sample 25)—possibly because the soil in the buried pithouse is more fertile and/or holds more soil moisture thus better supporting pooid growth.

The chloridoid component recovered in the pithouse 2 floor samples (see Table B-15) is lower than the chloridoid concentration found in pithouse 1 (see Table B-3). The pithouse 1 sample values are much more in line with the chloridoid concentration in the off-site environmental control samples in Table B-16 (sample 25 - the off-site control, and sample 14 which is the top of the eolian fill) which indicates a hotter drier environment during the

occupation of pithouse 1. The sample from pithouse 2 floor may be incomplete due to apparent soil pH/ phytolith dissolution issues. However, the evidence available indicates that the climate when pithouse 1 was occupied was warmer than during the earlier occupation of pithouse 2. Of course, duration of occupation and specific activities taking place inside the pithouses may alter the deposited phytolith record. The chloridoids may have been introduced by any number of means including naturally as part of the dust infiltrating the pithouse, carried in as part of a gathered plant material, tracked in, or shed from individuals or clothing. The higher frequency of burned chloridoids in pithouse 1 samples versus pithouse 2 suggests that chloridoids were either more numerous in the environment, actively gathered, and/or may suggest a season of occupation if the occupation was temporary.

If pithouse 1 supported a long-term habitation, the 3 to 4 cm thick pithouse floor soil samples analyzed do not enable resolution of the upper layer of floor dust present and thus the phytoliths deposited at the time the occupation ended. Assuming that pithouses 1 and 2 were occupied and utilized in a similar fashion, the floor phytolith signature in the later pithouse 1 does show the environment was generally hotter/drier than during the occupation of neighboring pithouse 2.

B.6 Results and Conclusions of Phytolith Data from the Long View Site (41RB112)

The botanical phytolith seasonality signature of the off-site control soil sample (sample 25) from a pristine prairie context on May 18, 2005 is most similar to the Dempsey Divide mixedgrass prairie control sample included in this discussion. Alluvial settings may distort the signature due to the presence of different species—particularly increasing the number of C_3 grass species and tree-related phytoliths.

Soil textural types were determined; all but one sample contained more than 50 percent sand.

The soil phytolith concentration was at the low end of what I have experienced in the past (in part due to the high sand content and also due to apparent phytolith preservation issues). The on-site control soil from a buried A horizon in the swale between the two components (sample 9) had less than half the phytolith concentration of the off-site control soil (sample 25). The only sample phytolith concentration higher than the off-site control soil was the upper end of eolian fill on top of construction fill towards western side of pithouse 2 (sample 14), which was post-occupation and thus potentially spared phytolith stability issues related to the occupation.

The sample phytolith seasonality plot (see Figure B-11), bulliform:short cell plot (Figure B-12), and the percent burned short cell phytoliths data Table B-7 are useful interpretative tools to help integrate the phytolith results with other site data.

Maize was present in Components A and C. Evidence of beans was absent in both components, and the cucurbit evidence was indeterminate.

Although charcoal was somewhat elevated in the on-site control sample (sample 9), no burned short cell phytoliths were observed. Additionally no large panicoid crosses or maize cob bodies (ruffle-topped rondels) were recovered from the control soil (sample 9). Likewise no beans or cucurbits were indicated. Phytolith preservation in this site area was apparently poor, likely at least in part due to presumed basic soil pH and the tendency of low ground to hold more moisture.

The discussions regarding sample signature similarities (e.g. seasonality indicators and charred phytolith incidence) provides clues about feature usage, food processing, related activity areas, and also implied seasonal information.

One interpretation of the burned hot dry season chloridoid phytoliths from pithouse 1 heating elements is that they indicate use during fall through early spring seasons. Assuming dry biomass was used in heating elements as tinder, the exclusive presence of burned hot dry saddle shaped chloridoid phytoliths in the three heating elements associated with pithouse 1 (see Table B-10) potentially suggests seasonal usage. However, the much higher concentration of burned saddles in the storage

Table B-14. Basin Heating Elements (Features 5 and 16), Ash Deposit (Feature 24), Storage Pit (Feature 23), and Dump (Feature 20)—Percent Burned Short Cell Phytolith Morphotypes.

Soil Sample Number	10 [F5]	21 [F16]	24 [F24]	23 [F23]	22 [F20}
Field Sample Number	120-4-4a	472-4-1a	644-4-1a	331-004-2b	234-4-1a
Percent Burned					
Keeled					
Conical	9.1	2.4	6.3	14.3	
Pyramidal	20		9.1		
Crenate	33.3				
Saddle, squat					
Saddle, tall					
Stipa	5.6				
Lobate, Simple	5.6	66.7			
Lobate, Panicoid	16.9		15.1		
Lobate, Panicoid (cmpd)					
Cross, Panicoid (<12 µ)	33.3	33.3			
Cross, Panicoid (>12 µ)	33.3		40		

Table B-15. Soil Sample Phytolith Counts - Pithouse 2 Floor Samples (41RB112).

	Soil 11	Soil 13	Soil 16	Soil 17	Soil 20
	Floor	N. wall profile	Below fill	Floor bottom	Floor, center
Phytolith Morphology					
Keeled	26	2	-	2	11
Conical	34	6	4	3	12
Pyramidal	15	-	4	6	3
Crenate	14	-	-	1	6
Saddle, squat	24	5	3	2	21
Saddle, tall	60	4	5	3	36
Stipa	4.5	1	1	-	3
Lobate, Simple	5	1	-	-	3
Lobate, Panicoid	16.5	-	5	-	41.5
Lobate, Pan'd (compound)	-	-	-	-	-
Cross, Panicoid (<12 um)	4	1	-	-	7
Cross, Panicoid (>12 um)	2	-	-	-	9
Maize Rondel	-	-	-	-	-
Dicot, knobby	-	-	-	-	1
Spiny spheroid	2	2	7	5	2
WWW, Schlerid	5	-	-	-	-
Diatom	-	-	-	-	1
Sponge spicule	-	1	2	-	2
Trichome, Hair Cells	14	1	4	4	13
Bulliform, square	34	12	11	13	13
Bulliform, rectangular	80	28	61	39	34
Bulliform, keystone	26	16	32	29	18
Bulliform, Y-shaped	6	1	5	-	2
Bulliform, other	161	80	194	163	80
Elongate, smooth	9	1	1	1	9
Elongate, sinuous	10	10	4	4	6
Elongate, castillate	8	3	6	8	10
Elongate, spiny	-	-	-	-	-
Other Misc. Forms	-	-	-	-	-
Charcoal	66	72	77	75	34
Possible Pinaceae tracheid elements ?	-	-	-	-	35
Sedges	6	1	-	-	2
Saddle Imposters	13	1	2	1	1
Large Discs	5	-	2	-	-

Table B-15. Soil Sample Phytolith Counts - Pithouse 2 Floor Samples (41RB112) (cont.)

	Soil 11	Soil 13	Soil 16	Soil 17	Soil 20
	Floor	N. wall profile	Below fill	Floor bottom	Floor, center
Phytolith Morphology					
Spore	-	-	-	-	-
Total Short Cell Counts:	205	20	22	17	152.5
Pooids (cool season)	89	8	8	12	32
Chloridoids (hot dry)	84	9	8	5	57
Panicoids (warm moist)	32	3	6	0	63.5
Normalized Short Cells (%)					
Pooids	43.4	40	36.3	70.6	21
Chloridoids	41	45	36.4	29.4	37.4
Panicoids	15.6	15	27.3	0	41.6
Total Bulliforms	307	137	303	244	147
Ratio Bulliform:Short Cells	1.5	6.85	13.77	14.35	0.96
Ratio Charcoal:Bulliform	0.21	0.53	0.25	0.31	0.23
Ratio Charcoal:Short Cells	0.32	3.6	3.5	4.41	0.22

Table B-16. Soil Sample Phytolith Counts – Pithouse 2 Construction/Roof Fall (12, 15, 18, and 19), Eolian Fill (14) and Off-Site Control (25)] Samples (41RB112).

	Soil 12	Soil 15	Soil 18	Soil 19	Soil 14	Soil 25
	Top of floor	Middle fill, W	Center	Fill	Eolian fill	Control soil
Phytolith Morphology						
Keeled	18	10	21	20	34	17
Conical	29	10	25	35	90	41
Pyramidal	20	5	1	20	24	11
Crenate	8	3	9	6	3	2
Saddle, squat	22	5	23	41	70	47
Saddle, tall	9	8	32	126	101	99
Stipa	9	5	4.5	9	13	8
Lobate, Simple	4	4	3.5	3	-	1
Lobate, Panicoid	27	27.5	74.5	60.5	3	6
Lobate, Pan'd (compound)	-	2	2	-	--	-
Cross, Panicoid (<12 um)	6	-	7	17	1	-
Cross, Panicoid (>12 um)	3	3	14	17	0.5	-
Maize Rondel	-	-	-	-	-	-
Dicot, knobby	-	-	2	-	-	-
Spiny spheroid	6	7	6	2	1	-
WWW, Schlerid	1	-	1	-	2	6
Diatom	-	3	2	2	1	7
Sponge spicule	-	6	2	-	-	1
Trichome, Hair Cells	28	30	8	11	11	11
Bulliform, square	58	46	16	8	30	12
Bulliform, rectangular	178	127	50	32	54	46
Bulliform, keystone	47	58	9	13	21	10
Bulliform, Y-shaped	6	-	26	2	1	8
Bulliform, other	320	409	61	94	114	74
Elongate, smooth	20	5	2	15	4	3
Elongate, sinuous	24	12	8	8	1	4
Elongate, castellate	16	7	3	16	6	4
Elongate, spiny	1	-	3	2	-	1
Other Misc. Forms	-	-	-	-	-	-
Charcoal	74	122	27	27	15	8
Possible Pinaceae tracheid elements ?	-	-	16	-	1	-
Sedges	1	-	-	2	-	2
Saddle Imposters	5	1	-	9	4	-

Table B-16. Soil Sample Phytolith Counts – Pithouse 2 Construction/Roof Fall (12, 15, 18, and 19), Eolian Fill (14) and Off-Site Control (25)] Samples (41RB112) (cont.)

	Soil 12	Soil 15	Soil 18	Soil 19	Soil 14	Soil 25
	Top of floor	Middle fill, W	Center	Fill	Eolian fill	Control soil
Phytolith Morphology						
Large Discs	1	1	-	5	1	-
Spore	-	-	-	-	1	-
Total Short Cell Counts:	195	82.5	230.5	354.5	339.5	232
Pooids (cool season)	75	28	70	81	151	71
Chloridoids (hot dry)	71	13	55	167	171	146
Panicoids (warm moist)	49	41.5	105.5	106.5	17.5	15
Normalized Short Cells (%)						
Pooids	38.5	33.9	30.3	22.9	44.4	30.6
Chloridoids	36.4	15.8	23.9	47.1	50.4	62.9
Panicoids	25.1	50.3	45.8	30	5.2	6.5
Total Bulliforms	609	640	162	149	220	150
Ratio Bulliform:Short Cells	3.12	7.76	0.7	0.42	0.65	0.65
Ratio Charcoal:Bulliform	0.12	0.19	0.17	0.18	0.07	0.05
Ratio Charcoal:Short Cells	0.38	1.48	0.12	0.08	0.04	0.03

pit Feature 13 (sample 7; Table B-10) causes one to wonder if this saddle usage was actually food preparation related, or alternatively if some residue from the elements was transferred to the pit. However, if the burned saddle phytoliths represent a byproduct of food processing, a fall activity is implied.

The assemblage in pithouse 2 Feature 6 was denser (e.g., more maize phytoliths, larger variety of burned phytolith morphologic types) which may indicate a more intense occupation, longer occupation, and/or more routine year-round activity areas.

The climate during the occupation of pithouse 1 appears to have been hotter than during pithouse 2.

All recovered sponge spicules were fragmentary and most had visible surface abrasion and occasional end-rounding which suggests mechanical movement and redeposition (i.e., via eolian and/or alluvial processes). No sponge gemmoscleres (the dormant or resting phase of sponges) were recovered. This evidence suggests that local sponge debris was not incidentally transported to the site via water-hauling activities, but is rather present as a natural environmentally-introduced soil component. Although the site was in close proximity to two creeks, there is no indication that extant sponge spicules were intentionally conveyed to the site at the time of occupation. A small number of statospores (formerly called Chrysophyte cysts) were also recovered. Recent information and illustrations regarding these particle types is available (Sudbury 2011c).

Obsidian was noted to be present, but not exhaustively investigated.

Both control soil samples were excellent additions to the sample inventory.

By carefully examining the soil fractions eliminated during the phytolith isolation procedure, additional important data was recovered (e.g., maize, teeth, and snail shells were recovered in the sand fraction).

Not sieving the soils in this study helped to preserve materials that would have otherwise been lost. In addition to the maize, jaw fragment, and snail shells, it is likely that the large tracheid elements that were recovered (see Figure B-16) would have been lost or significantly reduced in size had the samples been sieved as dictated by normally recommended and published laboratory protocols.

Integration of this phytolith data with the other analyses should help contribute to a better understanding of the site and the human behaviors.

A number of botanical reference specimens were processed seeking to identify unknown phytoliths and other particles encountered in this project. This substantial effort was specifically directed at identifying the source of the phytoliths illustrated in Figure B-16 which may be part of the pithouse roofing materials (and/or fuel, or from other applications). To date, these phytoliths have not been identified.

Additional reference specimen acquisition, analysis, and experimental work are ongoing to help answer unresolved issues encountered during this project.

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Bud Hampton and Mike Quigg generously provided samples of reference botanical specimens analyzed in the course of this study. Various suggestions and comments about specimen identification issues were generously provided by Calla McNamee, Barbara Winsborough, Chad Yost, Kent Buehler, Steve Bozarth, Mary Gard, and Debby Pearsall.

B.8 References

Bozarth, S.

1986 Morphologically Distinctive Phaseolus, Cucurbita, and Helianthus Annuus Phytoliths. In *Plant Opal Phytolith Analysis in Archaeology and Paleoecology*, edited by I. Rovner, pp. 56-66. Occasional Papers No. 1 of the Phytolitharien. North Carolina State University, Raleigh.

1987 Diagnostic Opal Phytoliths from Rinds of Selected Cucurbita Species. *American Antiquity* 52:607-615.

1990 Diagnostic Opal Phytoliths from Pods

of Selected Varieties of Common Beans (*Phaseolus vulgaris*). *American Antiquity* 55:98-104.

1993 Biosilicate Assemblages of Boreal Forests and Aspen Parklands. In *Current Research in Phytolith Analysis: Applications in Archaeology and Paleoecology*, edited by D. M. Pearsall, and D. R. Piperno, pp. 95-105. MASCA Research Papers in Science and Archaeology, Vol. 10. The University Museum of Archaeology and Anthropology, University of Pennsylvania, Philadelphia.

1988 Preliminary Opal Phytolith Analysis of Modern Analogs from Parklands, Mixed Forest, and Selected Conifer Stands in Prince Albert National Park, Saskatchewan. *Current Research in the Pleistocene* 5:45-46.

Pearsall, D. M.
1978 Phytolith Analysis of Archaeological Soils: Evidence for Maize Cultivation in Formative Ecuador. *Science* 199:177-178.

Pearsall, D. M., K. Chandler-Ezell, and A. Chandler-Ezell
2003 Identifying maize in neotropical sediments and soils using cob phytoliths. *Journal of Archaeological Science* 30:611-627.

Piperno, D. R.
2006 *Phytoliths A Comprehensive Guide for Archaeologists and Paleoecologists.* AltaMira Press, New York. 237 p.

Sudbury, J. B.
2007 Sewright Site (39FA1603) Phytolith Analysis. J. S. Enterprises Project Report 2007-2. Manuscript in possession of the author.

2011a Appendix E Phytoliths Present in a Buried Soil and Selected Cultural Features at 41YN452. In *Root-Be-Gone (41YN452): Data Recovery of Late Archaic Components in Young County, Texas, Volume 2*, by J. M. Quigg, P. M. Matchen, C. D. Frederick, and R. A. Ricklis, pp. 449-488. Texas Department of Transportation Environmental Affairs Division, Archeological Studies Program, Report No. 135. Austin, Texas.

2011b *Quantitative Phytolith Analysis—A Working Example from Modern Prairie Soils and Buried Holocene A Horizons.* Phytolith Press, Ponca City, Oklahoma. 288 p.

2011c *Biogenic Silica from an Opossum Creek Soil Profile, Nowata County, Oklahoma, USA.* Phytolith Press, Ponca City, Oklahoma. 107 p.

Sudbury, J. B., P. Colgate, M. Taylor, and D. G. Wyckoff.
2011 Sponge Spicules - An Under-utilized Soil Biogenic Silica Resource. Paper presented at the 8th International Meeting on Phytolith Research, Estes Park, Colorado, (September 17).

Yost, C.
2011 Commelinaceae see phytoliths in North America: recovery from archaeological and paleoecological contexts, and comparison to modern reference material. Paper presented at the 8th International Meeting on Phytolith Research, Estes Park, Colorado, (September 17).

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