LANDSCAPE LINES

7

Pollen, Phytolith, and Macroflora Analyses

Introduction

Pollen, phytolith, and macrofloral analyses are archeological techniques used to investigate the prehistory and history of vegetation types within a landscape. Data from these analyses provides information about former land use and changes in cultural activities over time. (See Figure 1.) Archeological and ethnobotanical expertise is required to analyze pollen, phytoliths, and macroflora.

The potential for pollen, phytolith, and macrofloral analyses to yield data about vegetation is highest when a site is undisturbed (for example, a site that has not received fill material or been inundated by flooding). In addition, information about a site is enhanced when the three techniques are conducted together. (The three analyses also complement other archeological techniques, such as the analysis of material artifacts.)

A pollen grain is the microscopic, single-celled male gamete of a flowering plant and a phytolith is a mineral fossil cast of a plant. The term, macroflora, refers to seeds and other macroscopic plant remains, such as wood, leaves, tubers, and flowers, that are preserved within an incubating sediment, such as soil. The remains of pollen, phytoliths, and macroflora can be collected from soil samples of a known deposition level within a soil profile. Based on their taxonomic classification and the soil strata in which they exist, the extant plant community of a prehistoric or historic period can be determined. In addition, the extent to which the pollen, phytolith, and macroflora remains are corroded or degraded can indicate the relative age of the sample.

Pollen Analysis

The Technique

To analyze pollen, a small soil sample is taken from each stratigraphic layer that has been excavated by an archeologist. Systematic excavations allow for classification of soils by temporal sequence, which creates reference points for analyzing the changes in a landscape over time. The classified soil samples are sent to a palynologist for pollen analysis. Because there are not many archaelogical palynologists in the United States, the analysis may take three to six months. Currently, the cost of analysis ranges from $85.00 to $150.00 per soil sample.

The pollen analysis of sediment taken from sample cores in wetlands may reveal more than soil samples taken from an archaeological excavation. There are two reasons for this: first, pollen grains are better preserved in wetland cores because there is less microbiotic activity, and second, wetland cores reveal more about the intervals between human and natural disturbances, such as fire, pathogens, and climate. (The occurrence of fire is determined by counting charcoal particles found in pollen samples.)

Preserved pollen grains are extracted from an incubating sediment, such as soil, by chemical and mechanical separation treatments. Then the grains

Figure 1. Photograph of Boott Cotton Mills and Yard, the site of numerous archeological investigations that included pollen and phytolith analyses. Lowell National Historical Park. (Photograph courtesy of the University of Massachusetts at Lowell, 1890)

are examined under a microscope to identify characteristics of the parent plant. Although some pollen can be classified at the subgenus or species level, most pollen cannot be identified below the level of genus. Some plant taxa have similar pollen characteristics, making it difficult to identify the plant below the level of family. For instance, chenopod and amaranth grass families are difficult to distinguish from just their pollen grains. Nearly every family of flowering plant has been investigated palynologically, though the accuracy of pollen information varies with each family. Palynologists can identify both dicotyledonous and monocotyledonous plants from their pollen, as well as fern spores, fungal spores, and algal cysts and spores.

Pollen can persist in soils for a long time, although its longevity is determined by such factors as exposure to oxygen, grain size, the initial abundance of pollen from a particular species, and durability of the pollen grain wall. The percentages of different taxa, determined by identifying pollen, does not necessarily represent the relative composition of vegetation in a particular period; rather, it indicates the presence of a particular plant community or taxa. While pollen preservation is generally poor in prehistoric sites, recent work indicates that pollen preservation in historic sites is generally adequate enough to yield valuable information about plant communities.

Applying Pollen Analysis to Cultural Landscape Research

Pollen analysis was originally used by paleoecologists to reconstruct the prehistoric environment. In recent years, archeologists have used pollen analysis to identify the plant communities that were extant in particular historic periods and relate vegetation changes over time to land use. Pollen data can also reveal information about climatic and ecological conditions within a particular period.

Pollen analysis has been used to chronicle the introduction of European flora with increased mercantile trade into the early colonies. For example, changing land use patterns in seventeenth century Jamestown, Virginia have been identified from preserved pollen. Similar patterns were identified at Lowell National Historical Park in Massachusetts and Harpers Ferry National Historical Park in West Virginia. In both of these landscapes, the pollen record indicated a transition from well maintained yards around dwellings at the turn of the nineteenth century to more unkempt, weedy environments corresponding with the period of the industrial revolution.

The presence of pollen in a soil sample indicates that a particular genus of plant was historically present in the vicinity, but it does not indicate the precise location of a particular plant taxa. This is due to the natural forces of wind and water that can affect the deposition and incubation of pollen. To determine the historical location of a plant taxa, soil samples must be analyzed for phytoliths, the mineral fossil casts of plants.

Phytolith Analysis

The Technique

Phytolith analysis is most often used to reconstruct vegetation cover over time. Phytoliths are released into the soil by plant decay, deposits of plant tissue in the soil through waste, and through cultural processing of plant tissue as fuel, food, fiber, or building material. The presence of phytoliths indicates the location of a plant, animal, or cultural activity, and can be used to reconstruct the microdistribution—the relative historic locations—of plants.

Phytoliths are formed when hydrated silicon dioxide precipitates out within plant cells and is deposited along cell walls, where it forms a hard, opaline microfossil cast. The phytoliths remain within the living plant and are released into the soil when the tissue is digested by decay organisms. Phytoliths are known to be very stable in the soil (typically more decay-resistant than pollen) and therefore may yield information about prehistoric conditions of a landscape. Phytoliths occur mostly in stems and leaves, though they may also form in root, flower, and fruit cells. Unlike pollen, phytoliths are associated with more than just flowering plants, so they have the potential to provide more information about the plant kingdom in a particular period.

Phytolith and pollen analysis are complementary techniques, with their relative strengths in monocotyledon and dicotyledon identification, respectively. Like pollen, phytoliths are identified through their morphological characteristics. A paleobotanist may perform the pollen and phytolith analyses concurrently. For the benefit of integrating pollen and phytolith data, pollen and phytoliths should be derived from the same soil samples.

Applying Phytolith Analysis to Cultural Landscape Research

Phytolith analysis is particularly revealing for monocotyledonous plants, especially the grass family. Many genera of grasses can be identified, yielding valuable ethnobotanical information about the cultural importance of grasses as food crops, building materials, and ornamental plants. For example, the presence of turf-grass phytoliths may indicate lawns in cultural landscapes.

At Lowell National Historical Park in Massachusetts and at Harpers Ferry National Historical Park in West Virginia, phytolith analysis was used in conjunction with pollen and artifact analysis to document change in land use during the industrial revolution of the nineteenth century. (See Figures 2 and 3.) At Hampton, Virginia, archeological investigations within the early city recovered teeth from domestic livestock. Phytoliths were extracted from the deposits on the teeth, providing a physical record of the eighteenth and nineteenth century diets of livestock and domestic animals. This information has been used to interpret 150 years of change in husbandry practices and land use at the household and community levels. The analysis of phytoliths was also used to identify historic field crop patterns at Monticello in Virginia, garden flora at the Moravian Gardens in North Carolina, Bacon's Castle in Virginia, and Morvan Gardens in New Jersey.

Figure 2. The Harper Yard is the site of numerous archeological investigations that included phytolith analysis. Information yielded in part through phytolith analysis contributed to a treatment plan proposing rehabilitation of the yard to reflect its nineteenth century character as a residential garden. Harpers Ferry National Historical Park. (NPS, 1991)

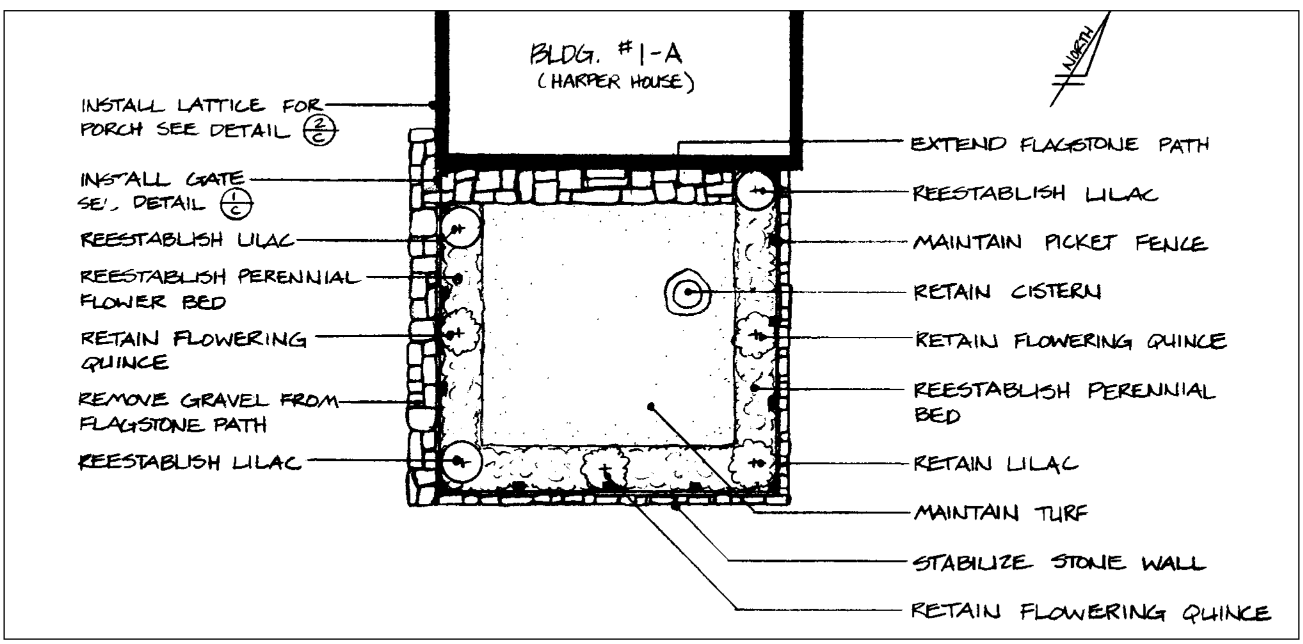

Figure 3. The proposed treatment plan for the Harper Yard. Information for the rehabilitation plan was partly derived from phytolith and pollen analyses of the yard. Harpers Ferry National Historical Park. (NPS, 1991)

Macroflora Analysis

The Technique

Macroflora analysis refers to the investigation of the macroscopic, buried remains of plants. These macroscopic remains include seeds, fruits, wood, leaves, roots, and tubers. Macroflora are identified according to their parent taxa and used to construct a history of indigenous and introduced vegetation. Macroflora are also a source of ethnobotanical information, which indicates the relationship between the plants and cultural activities of a landscape.

Macroflora are preserved for the longest duration in charcoalified form, caused by charring through human activities or naturally occurring fires. Charcoal (carbon) is a relatively inert substance that is not further decomposed by microorganisms. Few seeds live longer than a century and those persisting longer are usually charred. Carbon dating can be used to determine the relative age of charcoalified macroflora.

In the absence of charring, macroflora are best preserved in incubating conditions that are least favorable to the growth of decomposing microorganisms. Such conditions include arid, dry environments and conditions with a pH either more acid or alkaline than neutral. Most living organisms occupy a narrow pH range from slightly acid to neutral. More acid conditions, such as found in bogs and privies, retard the decomposition of organic material (macroflora) because the pH inhibits the growth of microorganisms. Anaerobic, waterlogged conditions are conducive to the carbonization of macroflora, a process similar to lignification (development of wood), which also retards decomposition.

Macroflora are derived from soil samples that have been classified according to their strata. Seeds may be incubated within human or mammalian waste (where they can provide dietary information), or directly within soil as a result of dispersal by wind, animals, and water. The macroflora analyst separates the seeds, leaves, fruits, or wood from the incubating sediment and observes the tissue under a light microscope to identify the parent taxa. Seeds and whole leaves can often be identified to the species level through examination of morphological characteristics. Certain dry fruits or succulent fruits, such as cherries and peaches, are identifiable to species. Wood must be diagnosed through the microscopic examination of conductive tissues and generally cannot be identified below the taxonomic level of genus.

Applying Macroflora Analysis to Cultural Landscape Research

Macroflora analysis is used with other archeological techniques to reconstruct the historic appearance of a cultural landscape. Charcoalified macroflora may be used to reconstruct vegetation cover in prehistoric periods. The analysis may indicate the presence of plant species in a particular period and also provide a temporal sequence of species change through successive periods. The pattern of vegetation change may be critical to understanding how a cultural landscape evolved as a result of human intervention and natural disturbances. (See Figure 4.)

Figure 4. Soil samples are collected during an archeological excavation, organized according to their respective soil strata, and analyzed for the presence of pollen, phytoliths, and macroflora. San Juan Island National Historical Park. (NPS, 1985)

Macroflora analysis can also contribute to the reconstruction of a landscape at a particular period. For example, at Monticello in Virginia, charcoalified seeds found in the ash of a servant's kitchen fireplace on Mulberry Row were identified as sorghum, watermelon, corn, peaches, and pokeberry. Here, macroflora analysis indicated some of the crops grown on the farm during Thomas Jefferson's occupation, and also contributed dietary information.

In New England, more general changes in vegetation over the past 2,000 years are being investigated using the record of macroflora and pollen deposited in lake beds in central Massachusetts. The identification of historically existing species and the study of vegetation dynamics will contribute to a land use and fire history.

A very large macroflora analysis was used to reconstruct the landscape of Pompeii, Italy. In A.D. 79, Mount Vesuvius erupted, destroying Pompeii and Heraculaneum. Vegetation incinerated during the eruption was preserved as charcoalified macroflora under a layer of pumice and ash many meters deep. Much of Pompeii has been excavated back to the level of the soil in A.D. 79. At the soil level, charcoalified roots are excavated and identified, or concrete casts are made of root cavities, leading to plant identification by shape or size. Charcoalified seeds, roots and branches of olives, peaches, almonds, grapes, and other woody plants are contributing information to the reconstruction of formal gardens and vineyards within the ancient city.

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