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# Phosphorous Concentrations at the Arner Site

Jenifer W. Putnam

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*Phosphate analysis of soil samples from the Arner site located in the Oglala National Grassland provides information on ancient activity patterns. This technique yields data that provide a direction for investigation during the next field season.*

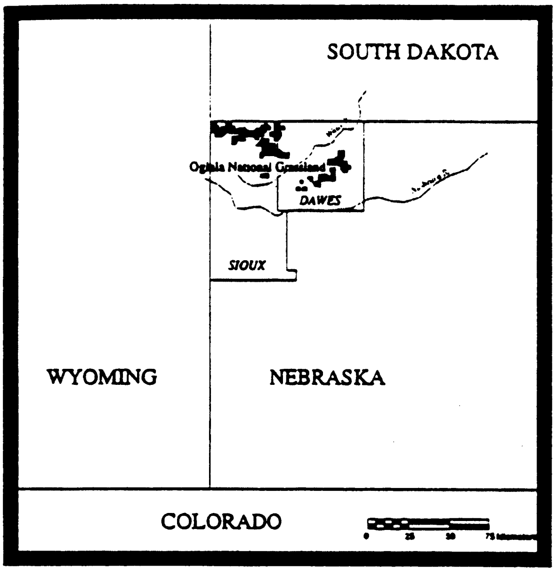


**Figure 1.** *Location of Oglala National Grassland in northwestern Nebraska.*

The Arner site is located in the Oglala National Grassland, located in northwestern Nebraska in the Little Badlands region of the White River (Figure 1). The climate is arid and the vegetation consists of grass seeds, yucca and prickly pear. This site is of interest because of the archeological features found there: pit hearths dated to as early as 659-694 AD.

One focus of the 1996 University of Nebraska-Lincoln archaeology field season was the collection of soil samples at the Arner site. It is possible to trace activity patterns by measuring the levels of phosphorous in the soil (Cavanagh 1988). At the Arner site, a paleosol with three distinct horizons is under study. The soil chemistry of Stratum III, an organically rich stratum, is the focus of this paper.

The study of paleosol phosphate content at the Arner site was inspired by a paper titled, "Soil Phosphate, Site Boundaries, and Change Point Analysis" (Cavanagh, et al. 1988). The objectives of the work discussed in that paper were to: 1) test phosphate values on the site that were higher than background values obtained away from sites; 2) compare surface distribution of phosphate with the distribution of sherds on the ground; 3) compare concentrations of phosphate against the distribution of sherds. At the Laconia Survey, Greece, Cavanagh's findings showed an overlap in time and displayed a potential boundary between two sites.

Conway pointed out that the phosphorous is deposited by a gradual accumulation of organic residues, that is, urine, dung, plant debris, and food refuse, in a random pattern, and ultimately enhancing the levels of phosphorous. "However, it is neither the overall volume of the waste that is important, but rather it is the spatial pattern of the deposition that will determine the usefulness of the phosphorous analysis at a particular site" (Conway 1983). He notes that levels may be changed by the deliberate action of humans, confining waste to dump sites or constructing buildings. Craddock (1985) points out that, among surface scatters of artifacts, phosphate analysis at an archaeological site gives a definite location of activity patterns around features.

At the Arner site, Stratum III phosphate values were derived from soil chemistry tests using a LaMotte Phosphate kit. The goal was to determine 1) variation in phosphate content across the site, and 2) the correspondence of phosphate content with the feature locations.

## MATERIALS AND METHODS

The LaMotte phosphate analysis relies upon a colorimetric technique which provides a measurement of phosphate values in parts per thousand.

The kit comes complete with test tubes, test tube caps, funnel, filter papers, phosphorous reagents, and a measuring cup for the soil sample.

Reagents include #1) Acetic Acid, Sodium Acetate; #2) Acetic Acid, Sodium Molybdate; and #3) Stannous Chloride, Potassium Chloride.

These step-by-step procedures were followed to conduct the phosphate content measurements:

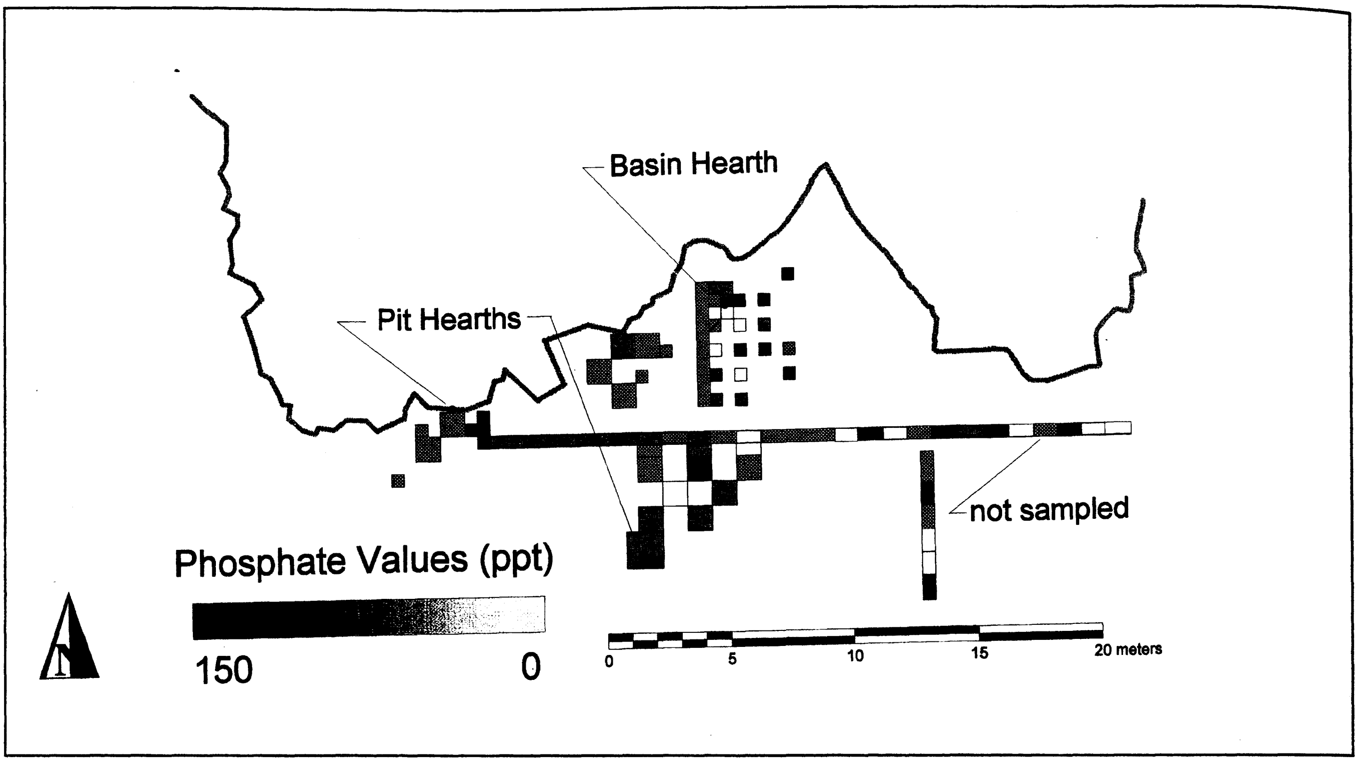


**Figure 2.** *Arner Site Stratum III Phosphate Values*

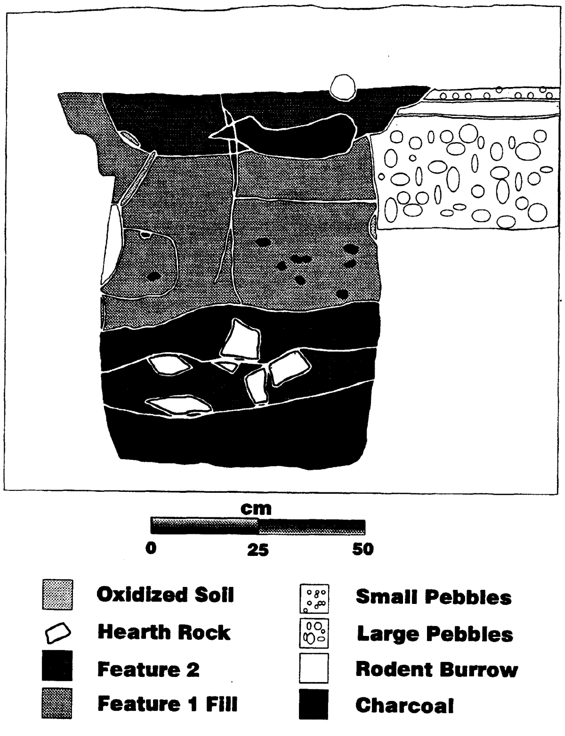


**Figure 3.** *Arner site feature profile: south wall of western-most pit hearth.*

1. Pour Reagent #1 into test tube "A" to the indicator mark and add the soil sample from the measuring cup. Cap and shake the test tube for one minute, keeping a firm grip while agitating. Let the soil settle to the bottom.

2. Prepare test tube "B" and insert funnel and filter paper. Pour only the clear liquid from test tube "A" into test tube "B." After the liquid is filtered it should rise to the indicator mark; if not, add a little more of the contents from test tube "A." When the liquid is filtered, add six drops of Reagent #2 and shake until mixed.

3. Add Reagent #3 (pellet), shake test tube until the pellet is dissolved, compare the color value to the scale supplied in the kit, and record findings.

## RESULTS

A total of 57 samples were systematically collected and processed on Stratum III at the Arner site. The range of values obtained from the tests were from 10 (indicating trace amounts) to 150 (indicating a very concentrated amount of phosphate). The results of the phosphate analysis are presented in Appendix A.

The phosphate values were then mapped (according to north and east coordinates of the sample unit) using a Geological Information Systems software, TNTMIPS (Figure 2). Phosphate findings on Stratum III demonstrate some interesting patterns, and provide an "X marks the spot" for digging in succeeding field seasons.

Phosphate findings on Stratum III demonstrate interesting patterns. The soil horizonation suggests dramatic variation in climate. Stratum III is a thick, black paleosol, which is indicative of a humid stable climate. In contrast, no soil development is seen in the modern sediment because the surface is not stable, a result of the windy, arid climate. There are no distinct boundaries defining the horizons, which are gradual in coloration as a result of bioturbation. Therefore, there is a potential that the chemistry of the strata could be mixed. There appears to be no water leeching which would lower the phosphate levels in Stratum III.

At the Arner site are three features, including two pit hearths and one basin hearth (see pit hearth profile, Figure 3). Of the two pit hearths, the pit hearth farthest west on the site dates 782-888 AD and 659-694 AD. The southern-most feature at the site, the second pit hearth, is undated.

Near the basin hearth, the phosphate levels were particularly high, ranging from 100-150 parts per thousand.

Samples with high levels of phosphate were also found in the eastern portion of the east-west transect on the site. Adjacent to the eastern part of the transect is another that runs perpendicular to the first (Figure 3). In addition, samples from the southern-most meter in the north-south transect demonstrated an extremely high concentration of phosphate, about 150 parts per thousand. Elsewhere, low to moderate value of phosphates were reported.

## CONCLUSION

This phosphate analysis will prove to be helpful in the succeeding field seasons, providing a better idea about the possible activity pattern occurring at the Arner site. It will be interesting to compare findings around the basin hearth with the predictions from the phosphate analysis to see if an occupation did occur and what activity was transpiring.

## REFERENCES CITED

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**Appendix A - Sample phosphate values, in parts per thousand (PPT)**

| Unit | North | East | Phosphate: PPT |
|---|---|---|---|
| P99-24 SE | 981 | 1029 | 150 |
| N99-13 NE | 982 | 1017 | 10 |
| N99-18 NW | 982 | 1018 | 75 |
| P99-23 SE | 982 | 1029 | 10 |
| N99-12 | 983 | 1017 | 25 |
| N99-19 SE | 983 | 1018 | 25 |
| P99-22 SE | 983 | 1029 | 10 |
| N99-20 SW | 984 | 1018 | 25 |
| O99-1 SW | 984 | 1020 | 10 |
| P99-21 SE | 984 | 1024 | 25 |
| N100-25 | 985 | 1019 | 10 |
| O100-6 SW | 985 | 1021 | 25 |
| P100-25 SE | 985 | 1029 | 100 |
| O100-4 SW | 986 | 1020 | 100 |
| O100-14 SW | 986 | 1022 | 25 |
| P100-24 SE | 986 | 1024 | 100 |
| M100-8 NE | 987 | 1011 | 75 |
| M100-13 NE | 987 | 1012 | 25 |
| M100-18 SW | 987 | 1013 | 25 |
| M100-23 NE | 987 | 1014 | 75 |
| N100-3 NE | 987 | 1015 | 25 |
| N100-8 | 987 | 1016 | 25 |
| N100-18 SW | 987 | 1018 | 25 |
| O100-3 SW | 987 | 1020 | 25 |
| O100-13 SW | 987 | 1022 | 10 |
| O100-18 NE | 987 | 1023 | 25 |
| O100-23 NE | 987 | 1024 | 75 |
| P100-8 | 987 | 1025 | 10 |

| Unit | North | East | Phosphate: PPT |
|---|---|---|---|
| P100-8 | 987 | 1026 | 10 |
| P100-13 NE | 987 | 1027 | 75 |
| P100-18 NE | 987 | 1028 | 10 |
| P100-23 NE | 987 | 1029 | 100 |
| Q100-3 | 987 | 1030 | 75 |
| Q100-8 | 987 | 1031 | 25 |
| Q100-13 | 987 | 1032 | 75 |
| Q100-18 | 987 | 1033 | 10 |
| 100-3 NE | 987 | 1035 | 75 |
| R100-3 | 987 | 1035 | 75 |
| R100-8 | 987 | 1036 | 10 |
| R100-13 SE | 987 | 1037 | 10 |
| M100-9 NE | 988 | 1011 | 100 |
| O100-10 SW | 989 | 1021 | 25 |
| O100-11 SW | 989 | 1022 | 25 |
| O101-6 SW | 990 | 1021 | 25 |
| O101-15 SW | 990 | 1022 | 10 |
| O101-25 SW | 990 | 1025 | 75 |
| O101-7 SW | 991 | 1021 | 10 |
| O101-14 | 991 | 1022 | 25 |
| O101-17 | 991 | 1023 | 25 |
| O101-8 SW | 992 | 1021 | 10 |
| O101-13 SW | 992 | 1022 | 10 |
| O101-18 SW | 992 | 1023 | 25 |
| O101-9 NW | 993 | 1021 | 25 |
| O101-13 SW | 993 | 1022 | 100 |
| O101-19 SW | 993 | 1023 | 150 |
| O101-21 SW | 994 | 1024 | 150 |