Prehistoric Agave Cultivation in Southern Arizona

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Abstract

Gathering of wild agave for food and fiber is widely recognized in ethnographic accounts of Southwestern Indians. Historically documented cultivation is limited to small-scale plantings and has not established agave as a significant aboriginal cultigen. The apparent absence of agave as a cultivated staple among peoples of the Sonoran Desert contrasts with pre-Columbian and historic ubiquity of this crop further south. It is a major cultigen throughout the rest of highland Mexico, including areas in Durango and Zacatecas, often considered within the greater Southwestern cultural sphere. Current archaeological evidence suggests that agave figured more prominently in prehistoric Southwestern agriculture than in that of subsequent groups.

Acknowledgments

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Introduction

Agave species of the Sonoran Desert grow mainly on rocky slopes of hills and mountains rather than in the valleys (Gentry, 1972:1). Distributional associations of *Agave parryi* Engelm. (Minnis and Plog, 1976) and *Agave murpheyi* F. Gibson (Crosswhite, 1981:58-59) with archaeological sites indicate a potentially active role for prehistoric Indians in spreading indigenous species beyond their natural range (Ford, 1981:21). In recent investigations, charred plant materials separated by flotation from sediments of Hohokam archaeological sites have included impressive amounts of agave. These sites in southern Arizona river valleys coincide poorly with natural distributions (Figure 1), yet in each case, agave is among the more common kinds of botanical remains. Cultivation near the sites rather than acquisition through trade has been proposed on the basis of overall quantity and the variety of plant parts (Gasser and Miksicek, *in press*).

Results and Discussion

Archaeological remains in the northern part of the Tucson Basin reveal the context and technology of Hohokam agave production. Farming took place on valley slopes or bajadas between the Santa Cruz floodplain and the Tortolita Mountains to the east. Here, limited modern surface disturbance has permitted preservation of unburied features left by prehistoric farmers. Small devices constructed from unmodified local cobbles and pebbles include short terraces, check dams across shallow drainages, and rockpiles. Rockpiles or rounded heaps (Figure 5) are the most common feature type, and the complexes of related agricultural features are called rockpile fields. Roasting pits filled with ash and fire-cracked rock are also present in most of the fields. Similar rockpile complexes have been recorded by archaeologists throughout the extent of Hohokam culture in southern and central Arizona (Figure 1), but have received little directed investigation until recently.

Charred plant remains recovered from roasting pits in the present study provide a consistent association between rockpile fields and agave. Sixteen excavated pits in 12 fields have yielded plentiful burned fragments of agave and, in rare instances, other economic plants. While a few Arizona agave species may occur at elevations comparable to the fields between 625 and 670 meters above sea level (Gentry, 1982), wild stands are absent today on bajadas in the 350-square kilometers of the Tucson Basin study area. If modern distributions are indicative, bulky agaves gathered at higher elevations in the Tortolita Mountains would have required transport down the slopes and up to 15 kilometers across the bajada. A more likely explanation of the strong correlation between agave-filled roasting pits and fields is cultivation or at least the tending of hypothetical and now extinct bajada stands.

Stone artifacts scattered widely across rockpile fields provide additional evidence for the immediacy of agaves. Broad, flat implements with edges sharpened by chipping and grinding constitute 19.2 percent of all chipped stone tools in systematic collections. These sorts of specialized tools, called agave or mescal knives, were used by Southwestern Indians (Castetter, Bell and Grove, 1938) to sever leaves from agave hearts in preparation for roasting. Broken knives are not simply concentrated near roasting pits, but occur

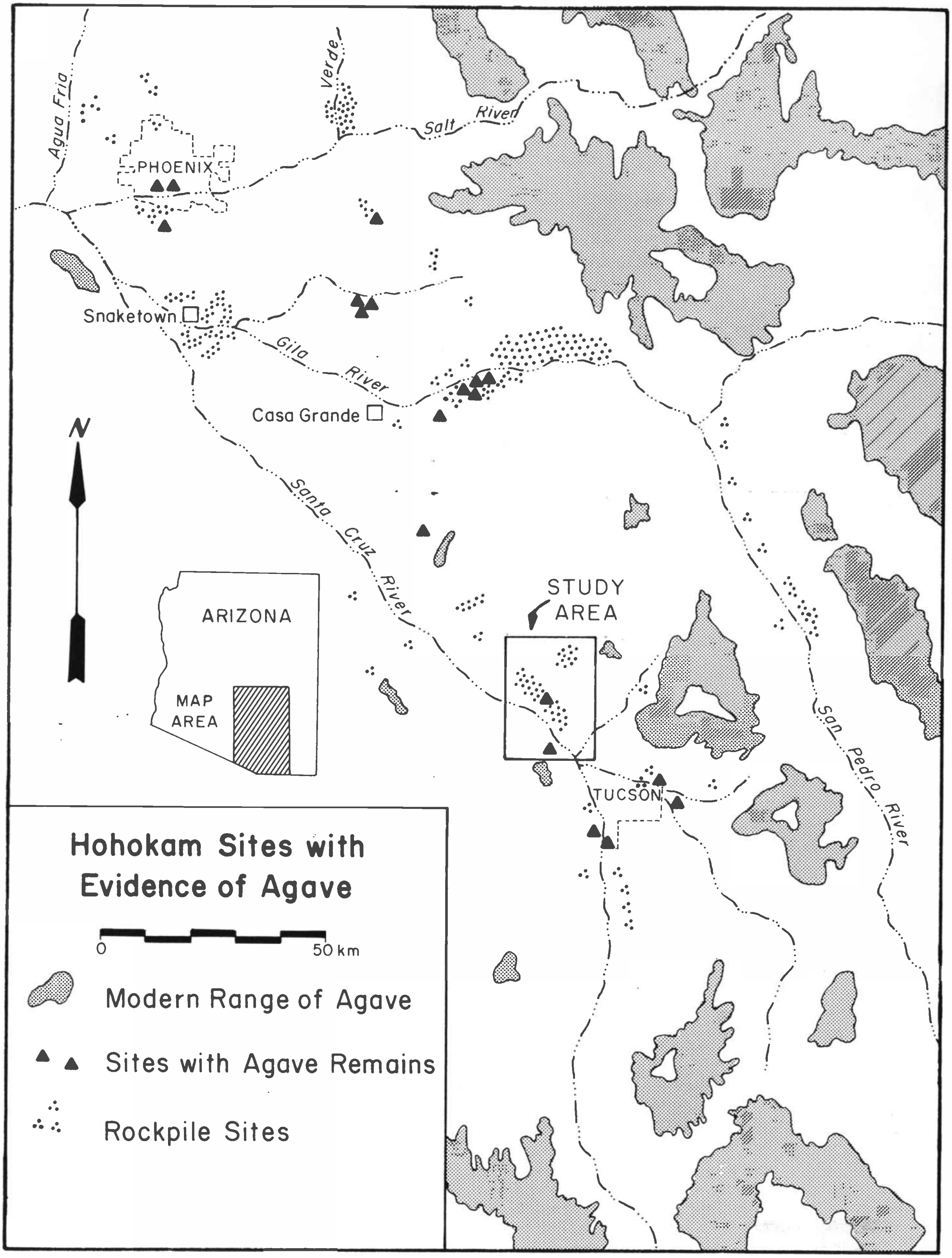

Figure 1. *The modern range of Agave is derived from Gentry (1982) and locations of elevations above 925 meters (3000 feet). Occurrences of rockpile loci have been compiled from site files at the University of Arizona, Arizona State University, and the Bureau of Land Management.*

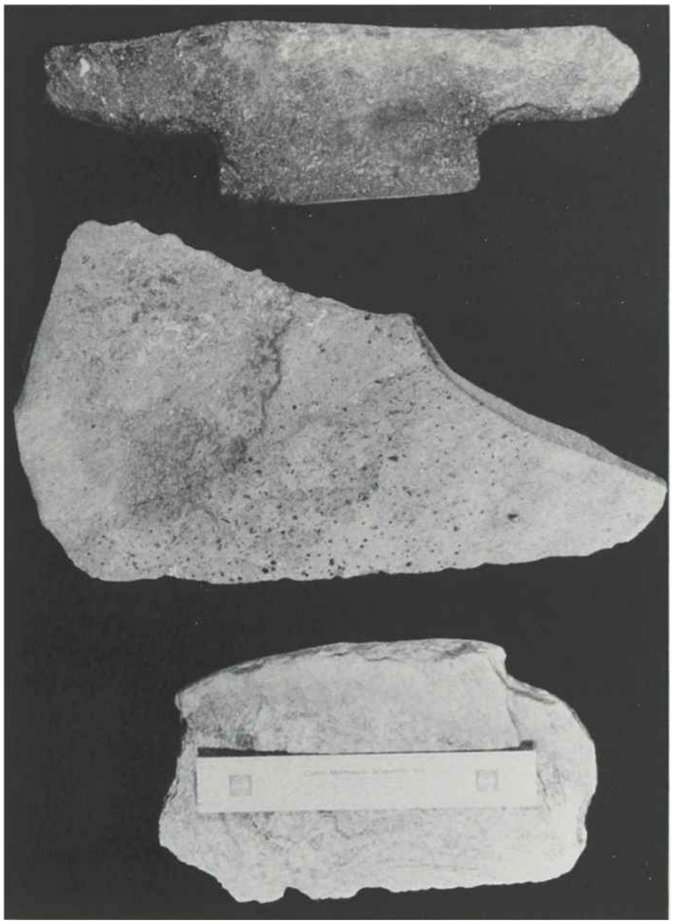

Figure 2. *Examples of different types of mescal knives from the Tucson study area.*

throughout the field areas as though discarded after damage during harvest (Figure 2).

Species roasted at rockpile fields cannot yet be determined with certainty. Whether gathered or cultivated, agaves are usually harvested prior to maturation of the flowering stalk and concurrent dissipation of stored nutrients. Thus, it is not surprising that floral and fruiting parts are lacking among charred remains. Since the majority of Southwestern aboriginal crops were of ultimate Mesoamerican origin, Mexican cultivars are a possibility. However, size of vegetative materials discounts the upper ranges of large Mexican species. Historic ethnic groups of the Sonoran Desert such as the Papago (Gentry, 1982:442-443) and the Seri (Felger, 1985) are known to transplant local species, a practice which could have been used by the Hohokam to insure plants preadapted to local conditions.

Isolated fibers, leaf bases, and caudex (heart) fragments are the most common types of "macrofossils." One almost complete terminal spine compares most favorably with *Agave murpheyi.* Prickles or marginal teeth (Figure 3) recovered from several pits resemble both *Agave parryi* and *murpheyi.* Examination of the epidermal patterns on better preserved leaf bases suggests that at least two or three species are represented. It seems likely that several species, one of which was probably *Agave murpheyi,* were cultivated by the prehistoric inhabitants of southern Arizona.

Mexican cultivation practices relate agaves to stone devices in field systems where annual crops are also planted

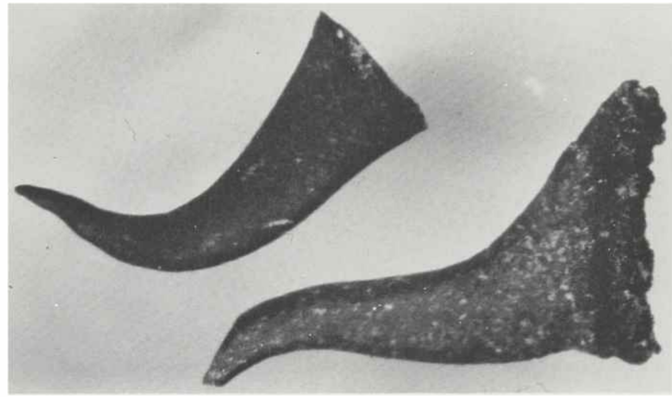

Figure 3. *Charred Agave prickles (marginal teeth) from a prehistoric roasting pit. The largest tooth is 6.0 mm long.*

in better-watered field segments or in seasons of favorable rainfall (Wilken, 1976; Johnson, 1978; Messer, 1978; Sanders et al., 1979). Such mixed cropping may be indicated by corn pollen in several shallow subsurface samples from fields, and by single cotton seeds recovered from each of two roasting pits. Mexican farmers often plant agaves along check dam and terrace walls, aiding in stabilization and soil and runoff entrapment. Moisture-enhanced microhabitats created by these features would benefit agaves on low, exposed slopes. The agricultural role of rockpiles cannot be similarly illuminated by observed historic use.

Multiple lines of evidence indicate that rockpiles as well as terraces and check dams are facilities of agricultural production. They are improbable as residuals of rock removal for planting. Some occur in the midst of dense concentrations of surface rock and some appear to have necessitated importation of rock for construction. Origin in surface clearing to increase runoff to more arable land as suggested for Negev Desert piles (Evenari et al., 1971:127-146), also seems unlikely. Many Tucson rockpiles are topographically situated so as to receive optimal runoff. Also, diversion devices for directing water to other sectors are not present in any field.

Uneven, porous rockpile surfaces allow infiltration of rainfall in contrast to surrounding hard-packed and impermeable ground surfaces. Rocks then act as a mulch, slowing evaporation of soil moisture by blocking capillary action and preserving higher moisture levels beneath. This effect of rocks in desert soils has been established experimentally (Evenari et al., 1971:260).

A continuing response by modern plants to the microhabitats of prehistoric rockpiles is demonstrated by preferential growth of perennials, comparatively dense annuals, and the presence of lichens and moss. This response has been quantified in the current study by comparing root biomass in soil directly beneath rockpiles and adjacent controls (Figure 4). Root weight in rockpile soil averaged 2.7 times the weight of roots in controls. These observations further strengthen an interpretation of rockpiles as moisture-enhancing facilities for crop plants.

Experimental agave plantings in prehistoric Tucson fields illustrate the adaptability of agave to these settings and suggest an additional benefit of cobble features. Viable leaves on 39 offsets or suckers of *Agave americana* L. were counted at planting in the early spring of 1984 and were

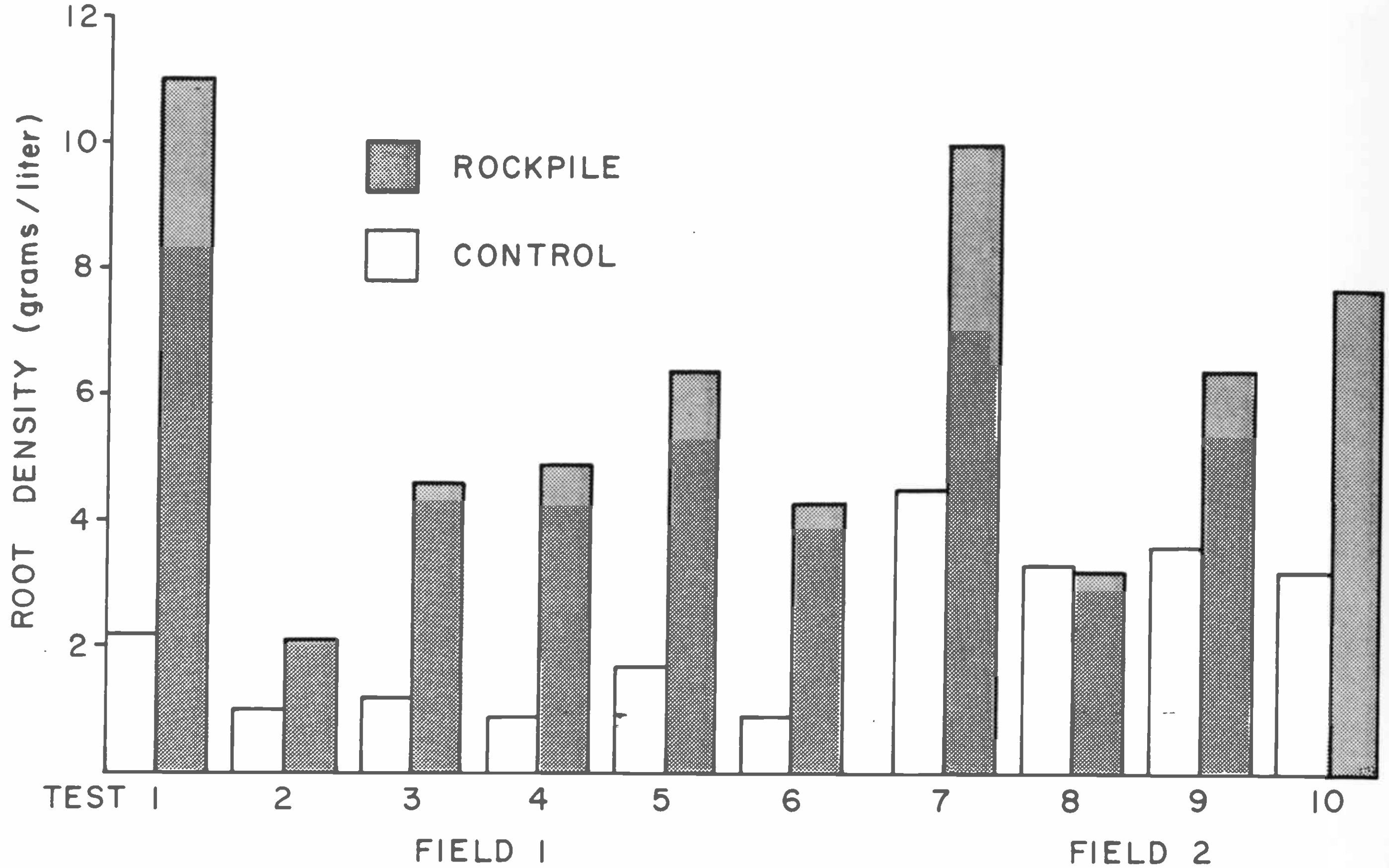

Figure 4: *Comparison of root biomass in rockpile soil samples and in adjacent control samples. Dry weight was determined after separation of roots from matrix by water flotation. Samples 1-6 are from one field and 7-10 from a second.*

tabulated again after the following summer rains. Average number of leaves increased 96 percent, from 3.0 to 5.9. Predation of leaves of all plants by rodents and possibly rabbits was heaviest after summer rains heightened succulence. Tunneling and occasional uprooting to procure roots and hearts occurred during the spring drought, when alternative food sources were low. Plants in rockpiles escaped this damage, unlike more vulnerable paired controls.

The nature and distributions of agricultural remains allow insight into the organization of Hohokam agave production. Archaeological survey of 350 square kilometers has been completed between the Tortolita Mountains and Tucson Mountains in the northern part of the Tucson Basin. Two preferred site locations for all periods parallel the flanks of the Tortolita Mountains and the Santa Cruz River. In the early Classical Period between about A.D. 1150 and 1300, population increased and a cluster of 320 interrelated sites covered 50 square kilometers (19 square miles) of bajada slopes between the floodplain and eastern foothills. A central site with a platform mound was located several miles from the present town of Marana. One of the unique aspects of this Classic Period settlement pattern was the elaboration of rockpile fields in general and the construction of very large ones in middle bajada locations.

The association of agave and roasting pits was not an innovation of the early Classic Period. A few small complexes of rockpiles, linear stone features, and roasting pits can be dated prior to A.D. 1000. While Classic Period field size was quite variable, differing combinations of these same feature types were used. With some larger and smaller exceptions, most rockpile diameters range near 1.5 meters, with heights no more than 75 centimeters. Checkdams across minor, shallow drainages and terraces trending across slopes are usually less than 10 meters long and composed of one to several cobble courses. Forty-one rockpile fields on the upper bajada cover less than two hectares each. Among 71 fields of the middle bajada, small ones are present as well as much larger complexes encompassing from 10 to 50 hectares. A portion of one such field is mapped in Figure 7.

The size and arrangement of fields have implications for farming labor and tenure. All upper bajada small fields are situated adjacent to habitation sites or include one or a few fieldhouse structures. In these cases, agricultural tenure seems linked to proximity. Both large and small fields of the middle bajada lack indications of nearby residence. Per unit of production, cultivators of these fields had to invest an added increment of travel time to and from their homes. Largescale complexes would have occupied many farmers, necessitating either some form of communal labor or commonly recognized intrafield boundaries. As among a number of Southwestern native peoples, kin-based or other corporate groups may have controlled arable land, with members assigned use rights to individual plots.

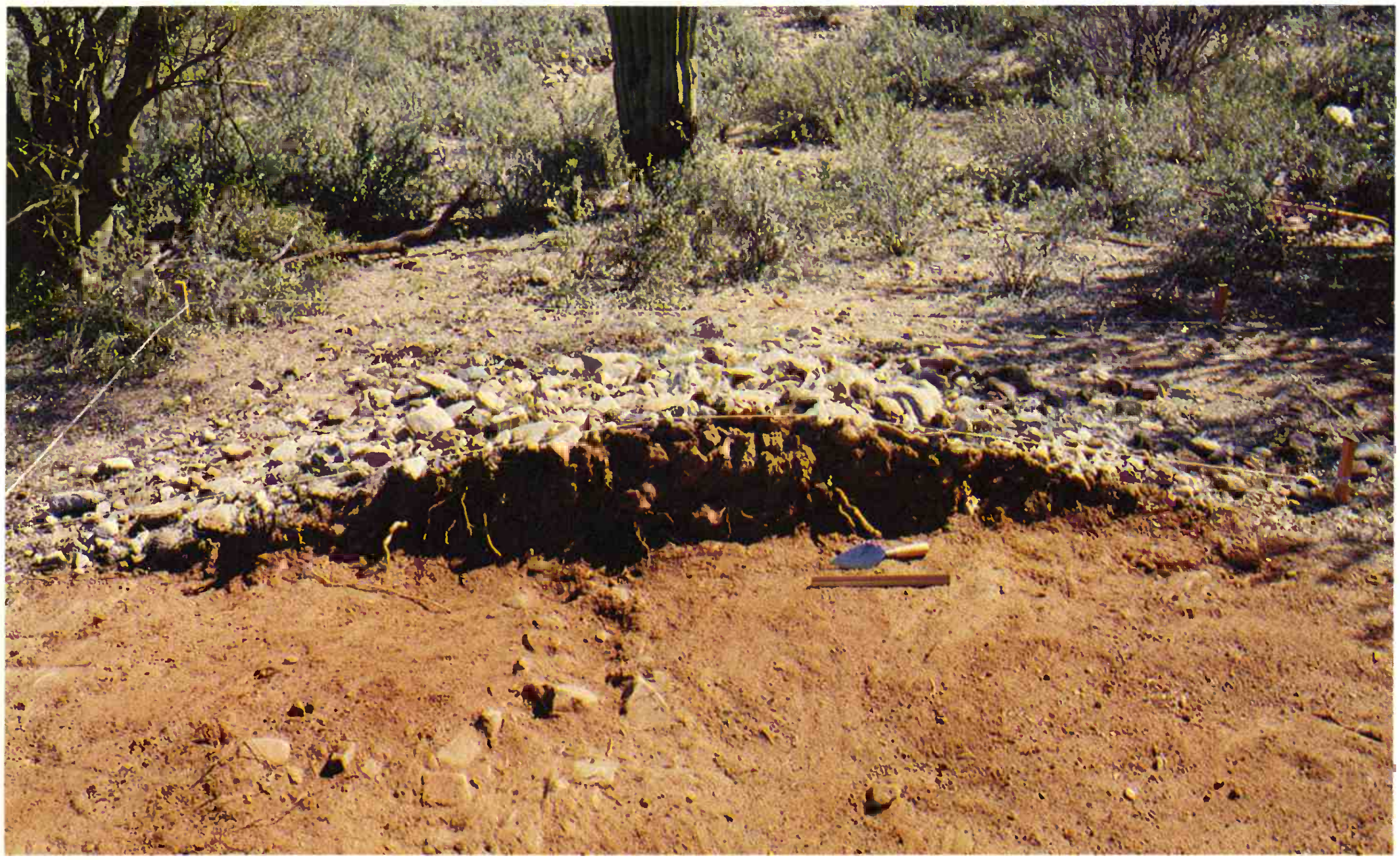

Figure 5. *Cross-section of a Tucson Basin rockpile.*

Figure 6. *A large roasting pit yielded charred Agave. The dark ashy surface stain marks a diameter of almost 30 meters. Pit roasting is the common ethnographic method for cooking edible Agave hearts and a means for facilitating fiber removal from leaves. Fuel species identified from prehistoric charcoal indicate vegetational communities like those of today.*

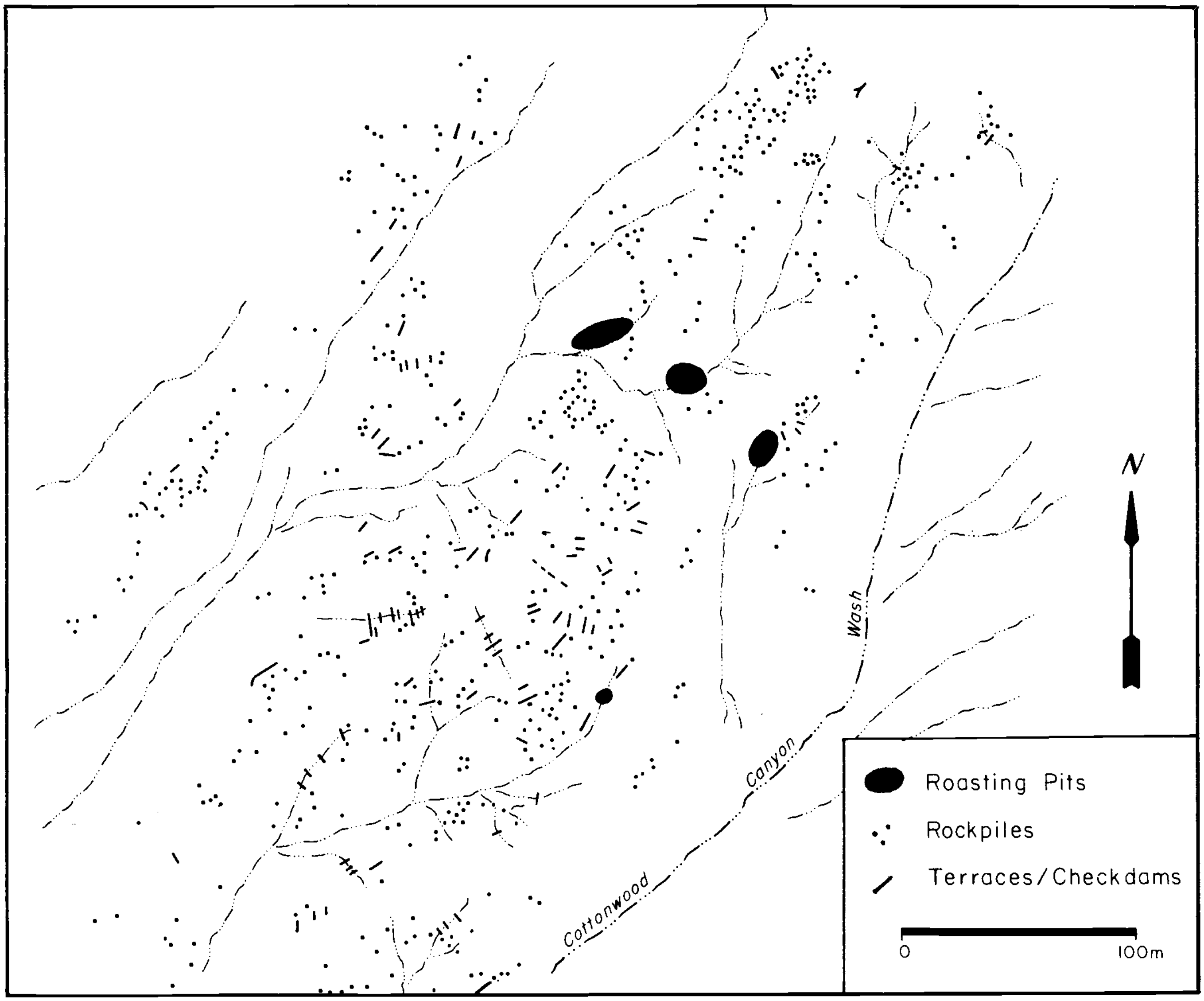

Figure 7. A portion of one large field of the middle bajada.

Roasting pit size tends to follow field size. Small pits about 3 meters in diameter are typical of small fields. Large fields are characterized by multiple huge features that might more properly be called roasting areas. Up to 35 meters in diameter (Figure 6), these features represent the accretion of repeated seasonal reuse, but show little evidence of small discrete firings. Cultivators would have had to coordinate harvesting and preparation of their plants. Collective roasting would have been an efficient use of desert woody fuels, revealed by charcoal to have consisted mainly of mesquite and ironwood. On the other hand, cultivators using the modest pits of small fields could have processed their harvests according to more individualized convenience.

The impressive scale of the large middle bajada rockpile fields is illustrated by the fact that they cover 485 hectares or over five square kilometers. Projecting numbers of rockpiles and meters of linear features from tabulated samples at representative fields, a total of 42,000 rockpiles and 120,000 meters of terraces and checkdams emerges. Experimental construction of features suggests that an initial expenditure of 50 man-years was required. Potential yields from the fields can be estimated by assuming one plant per rockpile and per two meters of linear feature, for a total of 102,000 plants at one time. With an average ten-year maturity for harvested plants, 10,200 agaves would have been available each year.

Agave hearts of small Southwestern species approximate four kilograms; at this rate, the large fields would have produced 40.8 metric tons of edible product. Furnishing 347 calories and 4.5 grams of protein per 100 grams (Ross, 1944), harvested agave could have supplied annual caloric requirements for 155 persons and protein requirements for 110 (FAO/WHO, 1973). Experimental fiber extraction in the present study suggests 365 grams of fiber per plant, for a 3.72 metric-ton annual crop. While all these estimates rely on modern analogy and experiment, they serve to demonstrate that agave production in rockpile fields could have added significantly to Hohokam diet and economy.

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Conclusions

The appearance of large middle bajada complexes, the expansion of total acreage in rockpile fields, and a concomitant emphasis on their yield have demographic correlates in the northern Tucson Basin. Site densities and population were at a peak in the early Classic Period. In an environment where aridity circumscribes agricultural activity, opportunities to expand irrigated or floodwater production were limited. Cultivation on marginal bajada slopes would have offered an optimal solution. Agaves are adapted to low and unreliable moisture to a greater degree than many annual crops. Poorer land could therefore be used to help satisfy growing needs for foodstuffs and craft supplies, as well as highly portable raw materials and finished products for trade.

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