The Fires of Grasshopper: Enlightening Transformations in Subsistence Practices through Fire-Feature Analysis

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This article is a case study of the changing fire features of the Grasshopper region of Arizona. Specifically, it focuses on the relationship between fire features and maize agriculture. The article shows that as the fourteenth century began, fire-feature patterns changed in this region and several entirely new fire-feature types appeared. While archaeologists have clearly demonstrated the intensification of maize agriculture during this same period, the possible links between maize and changing fire features have not been investigated. This article demonstrates that such links do in fact exist and that fire features respond dramatically to changes in human subsistence.

Fire features as prehistoric artifacts have many advantages. They are common, often well-preserved, and, since they are fixed features, unambiguous regarding location of use. Furthermore, they vary along multiple dimensions, including form, size, number, provenience, and attendant artifacts. They can provide information on manufacturing, ritual, social organization, and, as emphasized here, subsistence practices.

This case study of prehistoric fire-feature patterning focuses on the well-documented Grasshopper region of east-central Arizona during the thirteenth and fourteenth centuries. It demonstrates that impressive changes in fire features here are linked to a shift from moderate to intensive use of maize and from seasonal occupation in small hamlets to year-round sedentism in a large agricultural community. This analysis of variability in fire features offers valuable insights into subsistence change that are unavailable from other kinds of data.

BACKGROUND ON THE GRASSHOPPER REGION

For 30 years, from 1963 to 1992, the University of Arizona ran a summer field school in the Grasshopper region of Arizona (Longacre et al. 1982; Reid 1974, 1989). The region is particularly well researched, archaeologically rich, and tightly dated through dendrochronology, making it ideal for studying prehistoric cultural change.

The research area is located on the White Mountain Apache Indian Reservation in a rugged high-altitude environment. The climate is generally dry but with a summer period of torrential rains and difficult winters. It has a growing season of about 140 days and averages about 48 cm of rainfall (Reid 1989:69). Pinyon and juniper dominate the lower elevations and ponderosa pine, the higher.

Mogollon or Prehistoric Western Pueblo people occupied the region from about 1200 to 1400 A.D. They grew corn, beans, and squash and also hunted, especially deer and rabbits, and collected wild plants. The three
sites used in this study—Chodistaas (AZ P:14:24), Grasshopper Spring (AZ P:14:8), and Grasshopper (AZ P:14:1) Pueblos—were excavated extensively by the field school. Their occupations spanned a tumultuous transition from the thirteenth to the fourteenth centuries.

Chodistaas Pueblo (Fig. 1) is a single-story 18-room site with two room blocks and a walled plaza. It was occupied from 1263 to the late 1200s (Reid 1989:77). Since only Room 12 is not excavated, it is an unusually well-documented site. The pueblo burned at the end of its occupa-
tion, leaving a remarkable inventory of pottery and other artifacts on its floors and charred roof beams that allow accurate dating through dendrochronology. Each of the two room blocks has a specialized room with a platform that may be a protokiva (Rooms 2 and 18). Its excellent pottery inventory has spawned a number of important ceramic studies (Crown 1981; Montgomery 1992, 1993; Montgomery and Reid 1990; Reid and Montgomery 1998; Zedeno 1994).

Grasshopper Spring Pueblo (Fig. 2) is contemporary with Chodistaas Pueblo and only about 1.5 km away. Like Chodistaas, it is a single-story site, but, excluding the much-earlier rooms of Room Block 1 that are not included in this study, it is only half the size. Eight of the nine contemporary rooms have been excavated. Grasshopper Spring has one probable protokiva with a platform (Room 7), but no plaza. It, too, burned, leaving charred beams and an impressive collection of artifacts on its room floors.

Grasshopper Pueblo (Fig. 3) also began as a small village built in the late 1200s A.D. However, around 1300 A.D., just as Chodistaas and Grasshopper Spring were abandoned, it expanded rapidly to become the largest community in the area. The site has over 500 rooms and rises to two stories in some sections. More than 100 rooms have been excavated. There are three major room blocks (Room Blocks 1, 2, and 3) with 92 to 101 rooms each, numerous smaller room blocks, and three plazas. During the fourteenth century a roof was added to Plaza 3 and it was converted to a great kiva. Late in its occupation, Grasshopper Pueblo was only partially occupied, and outlying room blocks were used seasonally by the last occupants of the site. It was completely abandoned, as was the entire Grasshopper region, by about 1400 A.D. (Reid 1989:83–85; Reid and Whittlesey 1997:152–165).

The late thirteenth-century aggregation at Grasshopper Pueblo is linked to widespread disruptions that occurred across the American Southwest. This was a time of drought, regional abandonments that included the Four Corners area to the north, aggregation into large pueblos, and agricultural intensification (see Gumerman and Gell-Mann 1994). According to Wilcox and Haas (1994:236) warfare was common during this turbulent period and helped to spur the abandonment of some areas and aggregation for protection in others. The Grasshopper region participated in this general turmoil as a recipient of dislocated people. It had the attraction of being well watered compared to many other regions. Newcomers to the mountains apparently joined with the local mountain people as they left Chodistaas, Grasshopper Spring, and other small hamlets to live in large communities like Grasshopper Pueblo (Longacre 1975, 1976; Reid 1989:87–88).

Recent studies have demonstrated that, along with increased population and aggregation, a new focus on intensive maize agriculture appeared in the region (Ezzo 1993; Welch 1996). Ezzo’s (1993) analysis of bone chemistry from Grasshopper Pueblo burials identifies a broad shift from a diet relatively rich in wild plant and animal foods to one focused on maize. Although the early burials indicate some average dietary differences between males and females, later burials show that both sexes ate a heavy maize diet. Interestingly, Ezzo further infers some contrasts in diets among residents of the three main room blocks. This spatial variability does not show up in the fire-feature analysis, which finds no statistical differences among the room blocks. In the current study, therefore, Grasshopper Pueblo is considered as a whole, and additional research will be necessary to determine why these two data sources are somewhat at odds when the site is broken up into separate room blocks. Like Ezzo’s study, Welch’s (1996)
FIG. 3. Grasshopper Pueblo.
compilation of the limited pollen and flotation analyses that have been done to date also shows an increase in cultivated foods in the fourteenth century. Finally, the inference that maize became increasingly central to the diet is further supported by the location of Grasshopper Pueblo and the other large fourteenth-century sites of the region on the best land for agriculture (Reid 1989:81; Tuggle et al. 1984; Welch 1996).

Changes in material culture accompanied the intensified focus on maize, the influx of new people, and the organizational shifts required by aggregation and sedentism. Multistoried architecture and cliff-dwellings appeared in the region. The most common decorated pottery shifted from Cibola White Wares to Roosevelt Red Wares (Montgomery and Reid 1990; Zedeno 1994) and White Mountain Red Wares (Triadan 1997). This ceramic transition began while Chodistaas and Grasshopper Spring were still occupied. A shift from thick corner-notched to thin side-notched and unnotched projectile points also occurred. This style change came late to Chodistaas and continued at Grasshopper Pueblo, but did not show up at Grasshopper Spring (Lorentzen 1991). In addition, dramatic changes in fire-feature patterning took place. The standard types of fire features doubled from three to six. In this article I argue that the new types are tied to the increased emphasis on corn as a staple crop along with alterations in social organization appropriate for large-scale corn processing in an aggregated and sedentary community.

THE FIRES OF GRASSHOPPER

Variability in the fires of Grasshopper has long interested archaeologists. Previous studies focusing on Chodistaas household organization by Ciolek-Torrello (1985) and Reid and Whittlesey (1982) made important inferences relating fire features to room function. Ciolek-Torrello (1978, 1985:52), for instance, determined that rectangular slab-lined hearths were the primary cooking hearths in households at Grasshopper Pueblo. Ceremonial rooms and kivas were identified primarily by the presence of ceremonial hearths (Reid and Whittlesey 1982:693). In another study, Ciolek-Torrello and Reid (1974) documented that both hearth size and apparent household size decreased late in the occupation of Grasshopper Pueblo and suggested that the sizes of these hearths might be used to indicate relative household size.

In an earlier pilot study of fire-feature patterns (Lowell 1995), I analyzed 78 fire features from Chodistaas and Grasshopper Spring Pueblos and looked at the relationship between the forms and functions of the four thirteenth-types: circular clay-lined (CCL) hearths, rectangular slab-lined (RSL) hearths, circular unlined (CU) hearths, and roasting pits (RP). The fire-feature patterning of these sites captures the regional transition from seasonal occupation to year-round sedentism and from moderate to intensive maize cultivation. These changes occurred at Chodistaas, but not at Grasshopper Spring. Evidence includes the location of fire features both inside and outside of rooms at Chodistaas, indicating cooking in all seasons. Also at Chodistaas late-constructed storage rooms (Reid 1989:77) point to reliance on harvested crops that must be stored for year-round use (see Kent 1992). Finally, the presence of RSL hearths with their numerous associated grinding tools shows that a new food-processing technology related to maize appeared there.

In contrast to Chodistaas, Grasshopper Spring had no outdoor fire features, no storage rooms, and no rectangular slab-lined hearths. It apparently remained a seasonally occupied village until its abandonment. Furthermore, that all of the Grasshopper Spring rooms had some kind of fire feature and none were outside
signals cold-weather occupation. A small group of people might have come here on a seasonal basis, perhaps primarily to gather autumn nuts and to hunt deer, which are populous in the fall and winter (Ezzo 1993:23–24).

The subsistence changes and year-round sedentism that began in the late thirteenth century at Chodistaas are fully developed at Grasshopper Pueblo. The evidence for year-round sedentism in association with heavy maize use includes numerous storage rooms, indoor as well as outdoor fire features, and patterns of animal bones indicating animal consumption throughout the year (Olsen 1990:170).

**Methodology**

In this study, the fire features from Grasshopper Pueblo are added to those of Chodistaas and Grasshopper Spring, bringing the total in the computerized sample to 370, and with the addition of ovens and ceremonial hearths (CH), the clearly defined types to six. For each fire feature, information was entered into a computerized data set that included over 70 variables providing information on proveniences, dimensions, construction, associated features, and associated artifacts. For the statistical procedures SPSS PC was used. Statistical tests of significance included chi-square and analysis of variance. The $p < .05$ level of significance was utilized for rejection of the null hypothesis of no relationship between or among variables.

Artifacts considered to be associated with a particular fire feature either were labeled as such by the excavator or were within 1.5 m of the fire feature and clearly on the same level, as recorded on a floor map. All ceramics used in this analysis were whole or reconstructible vessels. If the associations of portable artifacts were not clear, that feature was dropped from any statistical analyses regarding portable artifacts, although it was kept in for other variables, such as provenience, dimensions, and associated features.

Of course, archaeologists must be cautious about assuming that portable artifacts found at the same level as a fixed feature and in close proximity to it were necessarily used with that feature or even in that physical place. In addition, they must consider that many artifacts used when the occupation surface was viable may be absent when the surface is excavated (see Schiffer 1987).

Fortunately, the three sites used here are unusually appropriate for analyses that relate portable objects to fixed features in a behaviorally meaningful way. As mentioned above, both Chodistaas and Grasshopper Spring burned, leaving robust inventories of artifacts on their room floors. The burning might have involved ritual (Montgomery 1993:161), a natural forest fire, or an act of war. Whatever the nature of their demise, these sites, while not quite as perfect as Pompeii (see Schiffer 1985), are remarkable in their apparent lack of later disturbance: numerous unbroken and potentially usable artifacts were left in place.

The site-formation processes of Grasshopper Pueblo are more complex than those of Chodistaas and Grasshopper Spring. This community was occupied longer, abandoned more slowly, and complicated by multiple stories and much remodeling. Early-abandoned rooms here were often reused as dumps, making inferences about associations between artifacts on their floors and fixed features less secure. However, the late-abandoned rooms at Grasshopper were not generally used for trash and are rich in usable floor artifacts (Ciolek-Torrelo 1985; Schiffer 1987:91). The final abandonment of Grasshopper Pueblo involved regional abandonment, and the last occupants apparently left for distant places carrying little with them. Later potential scavengers either did not exist or respected the prop-
property left behind (see Graves, Holbrook, and Longacre 1982:116–117; Graves, Longacre, and Holbrook 1982:201). In sum, these three sites in the Grasshopper region, while not perfect, are exceptionally valuable for analyses involving associations of portable artifacts and fixed features.

Furthermore, Schiffer’s principle of “recurrent associations” applies here. According to him,

“Recurrent associations” describe the situation one encounters when singular associations turn out not to be so singular after all, because the same items recur again and again, often in different recovery units. Thus, when manos and metates are found together many times, we may speak of their recurrent association. (Schiffer 1987:20)

In the present study, the significant associations between common fire features and artifacts (such as, between RSL hearths and grinding tools) occur across and between sites, so they are unusually robust and certainly have behavioral implications. Other possible associations are far weaker because of the low occurrences of the artifact or the feature type. These weaker patterns are so noted in the text and tables, and inferences related to them should be treated cautiously.

### Fire-Feature Typology

Six types of fire features are defined ($n = 302$). The earliest three are the circular clay-lined hearths, circular unlined hearths, and roasting pits. The three new forms are rectangular slab-lined hearths, ovens, and ceremonial hearths. Some fire features yielded poor information, so were termed Indeterminate Hearths ($n = 56$). These were disturbed or were simply areas of burned earth, some of which may have been used for firing pottery by using exterior fires flush with the ground, a technique documented among the historic Pueblos (Cushing 1920:312; Houlihan and Houlihan 1986:42; Stevenson 1904:375–377, Plate LXXXVII). Two other possible types occur that are not included in this study. Circular stone-lined hearths ($n = 8$) may have been similar to circular clay-lined or circular unlined types in function. Horizontal slab-lined hearths ($n = 4$) appear to be a late variant of RSL hearths.

The types are briefly described below, beginning with the two household cooking hearths: the circular clay-lined and rectangular slab-lined features. Of course, most fire features are multifunctional so that if a type is interpreted as primarily a cooking hearth it may also function to provide warmth and light. The tables may be

<table>
<thead>
<tr>
<th>Type</th>
<th>Number</th>
<th>Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCL</td>
<td>73</td>
<td>Elliptical hole; lining of clay; sometimes coped</td>
</tr>
<tr>
<td>CU</td>
<td>89</td>
<td>Elliptical hole; no lining</td>
</tr>
<tr>
<td>RP</td>
<td>20</td>
<td>Large and rock filled; shape variable; elliptical to rectangular to amorphous; unlined or lined with rock or clay</td>
</tr>
<tr>
<td>RSL</td>
<td>110</td>
<td>Rectangular; sides of upright stone slabs; some have slab base; most often remodeled</td>
</tr>
<tr>
<td>Ovens</td>
<td>3 sets</td>
<td>Rectangular; excavated below surface; formally built with masonry-lined side walls; in rows of three or more that share masonry sides; rock-filled</td>
</tr>
<tr>
<td>CH</td>
<td>7</td>
<td>Circular; stone lined; stones carefully shaped to form circular shape in plan view</td>
</tr>
</tbody>
</table>

Abbreviations: CCL, circular clay lined; CU, circular unlined; RP, roasting pit; RSL, rectangular slab lined; CH, ceremonial hearth.
consulted for detailed information on construction (Table 1), dimensions (Table 2), site distribution (Table 3), proveniences (Table 4), associated features (Table 5), associated ceramics (Table 6), and other associated artifacts (Table 7). Figures 4–9 depict typical hearths of each of the six types.

Circular clay-lined (CCL) hearths \((n = 73)\). These fire features (Fig. 4) are elliptical to circular in plan view and have an interior lining of clay (Table 1). They were multipurpose household hearths in the thirteenth century, but by the fourteenth, were eclipsed in importance by the rectangular slab-lined hearths (Table 3). The CCL hearths are remarkable for the many ceramics in association (Table 6). The numerous bowls and decorated vessels indicate that serving and dining were important activities around the circular clay-lined fire features. Crossculturally, both bowls, as vessels with easily accessible openings, and decorated vessels, which would be damaged by placement over the fire, are generally used for dining rather than cooking (see Rice 1987:240). Although rare, the mini-vessels tend to be found most often with this hearth type as well and further suggest dining, since they are useful for holding condiments. The frequent plain vessels and grinding tools point to food preparation as well as food

TABLE 2
Average Dimensions of Fire Features by Type

<table>
<thead>
<tr>
<th></th>
<th>CCL</th>
<th>CU</th>
<th>RP</th>
<th>RSL</th>
<th>Oven*</th>
<th>CH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>73</td>
<td>89</td>
<td>20</td>
<td>110</td>
<td>3 sets</td>
<td>7</td>
</tr>
<tr>
<td>Area (cm²)*</td>
<td>1,023</td>
<td>1,106</td>
<td>4,778</td>
<td>1,588</td>
<td>14,300</td>
<td>1,284</td>
</tr>
<tr>
<td>Depth (cm)*</td>
<td>16</td>
<td>13</td>
<td>35</td>
<td>21</td>
<td>85</td>
<td>29</td>
</tr>
<tr>
<td>Vol. (cc)*</td>
<td>14,939</td>
<td>16,212</td>
<td>185,188</td>
<td>34,468</td>
<td>1,215,500</td>
<td>41,747</td>
</tr>
</tbody>
</table>

* Oven measurements are from Oven No. 5 in south group.

p < .05 (ANOVA).

TABLE 3
Number and Percentage of Fire Features by Site*

<table>
<thead>
<tr>
<th></th>
<th>Grasshopper Spring</th>
<th>Chodistaas</th>
<th>Grasshopper</th>
<th>Total N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>CCL</td>
<td>5</td>
<td>42</td>
<td>25</td>
<td>38</td>
</tr>
<tr>
<td>CU</td>
<td>6</td>
<td>50</td>
<td>25</td>
<td>38</td>
</tr>
<tr>
<td>RP</td>
<td>1</td>
<td>8</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>RSL</td>
<td>0</td>
<td>0</td>
<td>13</td>
<td>20</td>
</tr>
<tr>
<td>Oven</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>CH</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>CSL b</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>HSL c</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>12</td>
<td>100</td>
<td>66</td>
<td>100</td>
</tr>
</tbody>
</table>

* p < .05 (Chi-square).

b CSL, circular stone-lined.
c HSL, horizontal slab-lined.
serving. Manos and metates are commonly in association, although these grinding tools are even more likely to occur with rectangular slab-lined hearths (Table 7). Mealing bins are unlikely to be in association (Table 5). The food-preparation techniques associated with these features are different from those associated with the rectangular slab-lined hearths, as discussed below.

**Rectangular slab-lined (RSL) hearths (n = 110).** These fire features (Fig. 5) are constructed of upright stone slabs arranged as a rectangle. They sometimes have a slab base. In room-function studies by Ciolek-Torrello (1985), Ciolek-Torrello and Reid (1974), and Reid and Whittlesey (1982:692), rectangular slab-lined hearths are identified as the primary household hearths at Grasshopper Pueblo. Regionally, they replaced the CCL hearths as the primary food-preparation fires. Their temporal patterning produced a significant chi-square test: There were none at Grasshopper spring, fewer than expected by chance at Chodistaas, and more than expected at Grasshopper. They accompanied the heavy reliance on maize agriculture documented by the fourteenth century. Of all the types, RSL hearths are the most likely to have grinding equipment in association. An impressive 93.5% of RSL hearths have manos present, 79.5% have metates, and 29.9% have mealing bins. This commonly associated grinding equipment indicates cooking involving corn meal processed for mush or bread. The RSL hearths usually have associated pottery, but not as commonly as the CCL hearths, and the pottery tends to be less

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**Table 4**

Proveniences by Fire Feature Type

<table>
<thead>
<tr>
<th>CCL</th>
<th>CU</th>
<th>RP</th>
<th>RSL</th>
<th>Oven</th>
<th>CH</th>
</tr>
</thead>
<tbody>
<tr>
<td>(n = 73)</td>
<td>(n = 89)</td>
<td>(n = 20)</td>
<td>(n = 107)</td>
<td>(n = 3 sets)</td>
<td>(n = 7)</td>
</tr>
<tr>
<td>% on ground floor</td>
<td>50.7</td>
<td>30.3</td>
<td>15</td>
<td>52.3</td>
<td>0</td>
</tr>
<tr>
<td>% on subfloor</td>
<td>11.0</td>
<td>23.6</td>
<td>20</td>
<td>6.5</td>
<td>0</td>
</tr>
<tr>
<td>% exterior</td>
<td>35.6</td>
<td>37.1</td>
<td>60</td>
<td>20.6</td>
<td>100</td>
</tr>
<tr>
<td>% above floor</td>
<td>0</td>
<td>6.7</td>
<td>5</td>
<td>6.5</td>
<td>0</td>
</tr>
<tr>
<td>% on second floor</td>
<td>2.7</td>
<td>0</td>
<td>0</td>
<td>4.7</td>
<td>0</td>
</tr>
<tr>
<td>% on roof</td>
<td>0</td>
<td>2.2</td>
<td>0</td>
<td>9.3</td>
<td>0</td>
</tr>
<tr>
<td>(n = 42)</td>
<td>(n = 33)</td>
<td>(n = 3)</td>
<td>(n = 62)</td>
<td>(n = 0)</td>
<td>(n = 7)</td>
</tr>
<tr>
<td>% in room center</td>
<td>26</td>
<td>15</td>
<td>33</td>
<td>74</td>
<td>0</td>
</tr>
</tbody>
</table>

*p < .05. Chi-square test for first six proveniences.

**These numbers apply to the first six proveniences only.

The subfloor label applies when it is unclear whether the fire feature was preroom (originally exterior) or on an earlier floor of the room.

The exterior label applies when the fire feature is clearly in a preroom (exterior) or plaza location.

The above-floor label applies when it is unclear whether the fire feature is on a second floor, in room fill, or on a roof.

*p < .05. Chi-square test for room center or room side provenience.

This variable includes only those fire features clearly within a room. Room-center fire features are placed to the center instead of to the side of the room.
frequently decorated. Both the undecorated pottery and frequent grinding equipment suggest that these features are more specialized for food preparation than the general-purpose CCL hearths.

The upright slab structure has a number of benefits. It is practical on second stories and roofs, since in these contexts digging down deeply to create the walls of a fire-pit is difficult. Indeed, at Grasshopper Pueblo RSL hearths are the most common types in above-ground proveniences (Table 4). The stone slabs probably retain heat better than earthen or clay-walled

| TABLE 5 |
| Percentage of Fire Features by Type with Particular Associated Features Present |
|---------|---------|---------|---------|---------|---------|
|         | CCL     | CU      | RP      | RSL     | CH      |
| n       | %       | n       | %       | n       | %       | n       | %       |
| Bin*    | 72<sup>a</sup> | 6.9     | 86      | 2.3     | 20      | 5.0     | 97      | 29.9    | 7       | 0       |
| Burial* | 63      | 31.7    | 60      | 33.3    | 16      | 62.5    | 92      | 27.2    | 4       | 50.0    |
| Pit*    | 50      | 4.0     | 56      | 12.5    | 9       | 33.3    | 71      | 8.5     | 4       | 75.0    |
| Cluster* | 38     | 5.3     | 41      | 4.9     | 8       | 25.0    | 45      | 6.7     | 2       | 0       |
| RSL     | 63      | 11.1    | 78      | 20.5    | 19      | 10.5    | 88      | 22.7    | 6       | 0       |
| CCL*    | 62      | 50.0    | 71      | 25.4    | 16      | 12.5    | 91      | 6.6     | 6       | 0       |
| CU*     | 59      | 25.4    | 65      | 52.3    | 13      | 7.7     | 88      | 11.4    | 6       | 0       |
| RP*     | 59      | 8.5     | 68      | 1.5     | 17      | 29.4    | 95      | 2.1     | 6       | 0       |

* <sup>a</sup> p < .05. Chi-square tests, using the presence or absence of an association between two features. Just the first four types are included in these significance tests.

* <sup>b</sup> The numbers give the counts of fire features by type that had adequate information for determining associations.

* <sup>c</sup> Cluster of chipped stone artifacts and debitage.

| TABLE 6 |
| Percentage of Fire Features by Type with Associated Ceramic Variables* |
|---------|---------|---------|---------|
|         | CCL     | CU      | RSL     |
| N*      | Variable | n<sup>c</sup> | %       | n<sup>c</sup> | %       | n<sup>c</sup> | %       |
| 33      | Decorated bowl<sup>d</sup> | 27<sup>d</sup> | 55.6    | 29      | 17.2    | 40      | 32.5    |
| 23      | Plain bowl<sup>e</sup> | 26      | 34.6    | 29      | 6.9     | 40      | 30.0    |
| 14      | Decorated jar<sup>f</sup> | 22      | 36.4    | 29      | 17.2    | 36      | 2.8     |
| 57      | Plain jar<sup>f</sup> | 27      | 77.8    | 29      | 37.9    | 39      | 64.1    |
| 10      | Minijar<sup>d</sup> | 26      | 23.1    | 29      | 3.4     | 38      | 7.9     |
| 3       | Minibowl | 26      | 11.5    | 29      | 0       | 38      | 0       |
| 12      | Plate    | 27      | 7.4     | 29      | 6.9     | 38      | 21.1    |
| 20      | Black-on-white<sup>d</sup> | 24      | 41.7    | 29      | 24.1    | 36      | 8.3     |
| 17      | Pinto<sup>e</sup> | 26      | 34.6    | 29      | 17.2    | 37      | 8.1     |
| 11      | Grasshopper<sup>e</sup> | 5       | 40.0    | 3       | 0       | 29      | 31.0    |
| 4       | Fourmile<sup>e</sup> | 6       | 33.3    | 6       | 0       | 29      | 6.9     |

* Some rare variables have been included here for interest, although with such low numbers statistical significance tests are not appropriate.

<sup>d</sup> The number of hearths of all types with this variable present.

<sup>e</sup> The number of fire features by type in each test.

<sup>f</sup> p < .05. Chi-square tests, using the presence or absence of an association between two variables.

<sup>e</sup> These types are found only at Grasshopper Pueblo.
structures. Also, the slabs reinforce the sides of the fire feature if the soil is loose. In addition, the raised sides are effective for supporting sticks in spit-cooking meat (see Sobolik et al. 1997). Finally, as discussed below, the slabs are useful for supporting cooking pots.

**Circular unlined (CU) hearths (n = 89).** These simple fire features (Fig. 6) were used primarily for heat and light. They are elliptical to circular in plan view and excavated into the ground. They are present in all three sites, but are most common in the earlier sites (Table 3). Although they do occur on room floors, they are most frequently found in exterior locations. When compared to the CCL and RSL hearths, the lower frequencies of grinding equipment, mealing bins, plainware vessels, and bowls point to less emphasis on cooking and dining. I suggest that these unlined fire pits are the most easily built, so they were constructed whenever heat or light was required for a variety of activities. Their scattered proveniences support this inference. Some CU hearths may have been used as heating facilities in interior sleeping areas, particularly in the earlier sites, since even in interior locations they tend to have few associated artifacts.

**Roasting pits (RP) (n = 20).** These are large, deep, rock-filled fire features (Fig. 7). The rocks are useful for retaining heat to slowly roast meat or other foods (see Wandsnider 1997). Their shapes vary from

### TABLE 7
Percentage of Fire Features by Type with Selected Associated Artifacts

<table>
<thead>
<tr>
<th>N°</th>
<th>Artifact</th>
<th>CCL</th>
<th>%</th>
<th>CU</th>
<th>%</th>
<th>RP</th>
<th>%</th>
<th>RSL</th>
<th>%</th>
<th>CH</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>72</td>
<td>Mano(^b)</td>
<td>28 (^c)</td>
<td>71.4</td>
<td>16</td>
<td>43.8</td>
<td>8</td>
<td>25.0</td>
<td>46</td>
<td>93.5</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>55</td>
<td>Metate(^b)</td>
<td>25</td>
<td>48.0</td>
<td>15</td>
<td>40.0</td>
<td>8</td>
<td>25.0</td>
<td>44</td>
<td>79.5</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>21</td>
<td>Awl(^b)</td>
<td>24</td>
<td>8.3</td>
<td>16</td>
<td>6.3</td>
<td>9</td>
<td>22.2</td>
<td>41</td>
<td>39.0</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>36</td>
<td>Hammerstone(^b)</td>
<td>24</td>
<td>29.1</td>
<td>15</td>
<td>13.3</td>
<td>9</td>
<td>55.6</td>
<td>40</td>
<td>55.0</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>34</td>
<td>Unworked bone(^b)</td>
<td>25</td>
<td>36.0</td>
<td>18</td>
<td>33.3</td>
<td>10</td>
<td>80.0</td>
<td>44</td>
<td>25.0</td>
<td>4</td>
<td>50</td>
</tr>
<tr>
<td>27</td>
<td>Polishing stone</td>
<td>25</td>
<td>16.0</td>
<td>15</td>
<td>33.3</td>
<td>8</td>
<td>25.0</td>
<td>40</td>
<td>40.0</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>20</td>
<td>Axe</td>
<td>24</td>
<td>12.5</td>
<td>16</td>
<td>18.8</td>
<td>8</td>
<td>12.5</td>
<td>40</td>
<td>32.5</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>12</td>
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</tr>
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<td>20</td>
<td>Hematite</td>
<td>26</td>
<td>34.6</td>
<td>15</td>
<td>6.7</td>
<td>9</td>
<td>22.2</td>
<td>38</td>
<td>21.1</td>
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<td>12.5</td>
<td>41</td>
<td>17.1</td>
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<td>0</td>
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<td>23</td>
<td>Projectile point</td>
<td>24</td>
<td>20.8</td>
<td>16</td>
<td>18.8</td>
<td>10</td>
<td>40.0</td>
<td>41</td>
<td>26.8</td>
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<td>50</td>
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<td>Core</td>
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<td>41.7</td>
<td>15</td>
<td>40.0</td>
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<td>55.6</td>
<td>39</td>
<td>33.3</td>
<td>3</td>
<td>33.3</td>
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<tr>
<td>11</td>
<td>Worked bone</td>
<td>24</td>
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<td>15</td>
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<td>12.5</td>
<td>38</td>
<td>18.4</td>
<td>3</td>
<td>33.3</td>
</tr>
<tr>
<td>12</td>
<td>Antler</td>
<td>24</td>
<td>12.5</td>
<td>15</td>
<td>6.7</td>
<td>8</td>
<td>0.0</td>
<td>39</td>
<td>20.5</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>11</td>
<td>Shaft</td>
<td>24</td>
<td>12.5</td>
<td>15</td>
<td>6.7</td>
<td>8</td>
<td>12.5</td>
<td>39</td>
<td>15.4</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>18</td>
<td>Ground stone (misc.)</td>
<td>5</td>
<td>8.0</td>
<td>15</td>
<td>20.0</td>
<td>8</td>
<td>25.0</td>
<td>41</td>
<td>26.8</td>
<td>3</td>
<td>33.3</td>
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<td>Knife</td>
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<td>12.5</td>
<td>39</td>
<td>17.9</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>

\(^a\) Number of fire-feature types, excluding the ceremonial hearths, with this artifact type present.

\(^b\) \(p < .05\). Chi-square tests, using the presence or absence of an association between two variables. The ceremonial hearths were left out of these significance tests because of low numbers.

\(^c\) Number of fire features by type included in the table.
elliptical to rectangular to amorphous. The sides are unlined or lined with rock or clay. They are generally exterior in location. The patterning of associated portable artifacts is interesting, but should be treated cautiously given the small number of roasting pits with clearly associated artifacts (Table 7). Pottery and manos and metates are uncommon, but 40% have projectile points and 25% have chipped-stone clusters nearby. A significant chi-square test shows that associated unworked bone is more common than with other features, indicating that these fire features may be specialized for cooking meat. An impressive 8 of the 10 with good

data for associated artifacts had bone in association. Charcoal is always found in roasting pits, implying that their fires were smothered or doused rather than being left to burn down to ash. The presence of roasting pits is stable across all three sites (Table 3), with the expected and actual numbers very close in each case. Roasting pits are the only fire features that show such temporal consistency.

Ovens (n = 3 sets of three or more ovens). Ovens (Fig. 8) are the largest fire features and are found only at Grasshopper Pueblo. To my knowledge these impressive features are unique to the prehistoric Southwest. They are rectangular,
constructed of masonry, and arranged in rows of three or more that share masonry sides in the same way that typical pueblo rooms share walls. One set was found associated with each of the three major room blocks (Fig. 3). All were exterior features, although the one associated with Room Block 3 was covered by later room construction.

Because the files on the excavations of these features are incomplete, no statistical tests were carried out. The report on Oven 5 (Fig. 8), from the set located off the southern end of Room Block 2 at Grasshopper Pueblo (Fig. 3), is used for the measurements given on Table 2. Like roasting pits, ovens are rock filled. Flotation from one set produced numerous corn kernels and corn-cob fragments. Also, some other seeds, nutshells, and bone were found. The cobs and kernels indicate that corn in its unground state was one major food cooked (see Bohrer 1982:98–99), but other foods, including meat, were probably cooked as well. Although larger and more formal in construction than the roasting pits, the Grasshopper ovens may overlap with them in function. However, I argue below that the Grasshopper ovens served the crucial function of cooking corn-on-the-cob at harvest time, for feasting, and, most importantly, for long-term storage (see Wandsnider 1997:26–28).

Ceremonial hearths (CH) \( (n = 7) \). Like the ovens, these distinctive features (Fig. 9) are found only at Grasshopper Pueblo. They were carefully constructed and lined with stone. The top stones were shaped to produce a tidy circular shape in plan view. Kivas and ceremonial rooms at Grasshopper Pueblo are traditionally defined by the presence of ceremonial hearths along with other uncommon features like benches (Ciolek-Torrello 1985; Reid and Whittlesey 1982:693).

No mealing bins, roasting pits, RSL hearths, CCL hearths, or CU hearths were associated with the ceremonial hearths. Two of the four good cases for subfloor associations had pits and burials associated. Three of the seven had an associated slab-lined box of unknown function. Just a few of these hearths had clearly associated portable artifacts, including projectile points, cores, and worked and unworked bone. The following never occur: manos, metates, polishing stones, axes, hematite, awls, ornaments, hammerstones, and pigment. Ceramics are uncommon. The inference that these are ritual hearths is strengthened by the association with burials. The lack of cooking and serving equipment further suggests that they were used primarily for heat and light. Because the rarity of this type of fire feature is problematic for statistical significance testing, it was dropped from most procedures.
FIG. 7. Roasting pit (RP).

- Ash & charcoal
- Rock fill
- Clay lining
- Fire reddened earth
- Subfloor
FIG. 8. Oven.
Summary of the fire-feature typology. In sum, six fire-feature types have been defined. Circular clay-lined hearths were the major domestic cooking hearths in the thirteenth-century sites and became less important over time. Rectangular slab-
lined hearths were used to prepare ground corn and replaced the CCL hearths to become the major domestic hearths in the fourteenth century. Circular unlined hearths were primarily for warmth and light and, like the CCL hearths, also decreased in importance through time. The roasting pits were primarily outdoor features used to cook meat and remained consistent through time. Ovens were also outdoor features, but were present only at Grasshopper Pueblo and probably functioned to roast corn-on-the-cob. Finally, ceremonial hearths, also only at Grasshopper Pueblo, were used to provide warmth and light in kivas and ceremonial rooms.

INSIGHTS INTO COOKING PRACTICES FROM ETHNOGRAPHIC STUDIES

Early accounts of Hopi, Zuni, Yuman, Pima, Papago, Tarahumara, Apache, and Navajo food preparation provide helpful ideas about how foods may have been cooked by Southwest groups in prehistory. The variety of non-European foods documented ethnographically is impressive, as is the array of methods for preparing and cooking them. Numerous wild plants and animals as well as domesticated plants were consumed. Maize, which comes in many varieties, was the most important domestic crop, with various kinds of beans and squashes of secondary importance. The common techniques for cooking included boiling in pots, pit baking, cooking foods directly in ashes and coals, skewering (especially meat) over the fire, parching, and griddling.

Unfortunately, in only limited cases are the actual forms of the fires clearly documented. Furthermore, many of the types that are documented are not found prehistorically in the Grasshopper region. For example, Hopi and Zuni stone griddles are supported on a two- or three-slab fire feature (Adams 1991:82; Cushing 1920:317–343; Mindeleff 1891:175–176; Stevenson 1904:361–362). Neither the griddles nor the fire features occur at Grasshopper. Domed ovens (Cushing 1920:265; Mindeleff 1891:163–166; Stevenson 1904:364–365), common in many historic Grasshopper sites, are post-European, along with hoods and chimney (Mindeleff 1891:167–180). Conversely, some types identified in the prehistoric record are not clearly documented ethnographically. These include the pivotal RSL hearths, the type that is so common after 1300 A.D. in the Grasshopper region and elsewhere among the prehistoric Pueblos.

How was the all-important crop, maize, traditionally prepared and cooked by American Indians of the greater Southwest? Ethnographic documentation presents a multitude of techniques, many of which were widespread and therefore indicative of early and non-European origins. Corn was cooked on the cob in large roasting pits at harvest time (Buskirk 1986:82–83, 202; Castetter and Bell 1942:182; Cushing 1979:275–277; Kluckhohn et al. 1971:130–132; Stevenson 1904:367) or simply stuck into the ashes and coals of a fire at other times (Cushing 1920:264; Bennett and Zingg 1935:35). Certain varieties were popped in jars (Stevenson 1904:367). Corn kernels were boiled into hominy (Bennett and Zingg 1935:32; Stevenson 1904:367). Ground corn may have been dissolved into a drink (Bennett and Zingg 1935:32; Stevenson 1904:369).

The preparation of ground maize dough is especially important and requires elaborate procedures. To produce the dough, the corn is generally parched first then boiled in alkaline water and ground. It can be ground finely on three grinding stones of different degrees of coarseness or more coarsely on one or two stones. Once prepared, the dough may be turned into cakes that are baked in ovens (Stevenson 1904:364), placed directly into the fire and
ashes to cook (Bennett and Zingg 1935:32; Buskirk 1986:82; Cushing 1920:303), or shaped into tortillas or thin wafer breads and cooked on stone (Adams 1991:82; Cushing 1920:317–343) or pottery griddles (Bennett and Zingg 1935:33). Alternatively, the dough may be boiled in water for mushes, stews, or dumplings (Bennett and Zingg 1935:33; Buskirk 1986:82; Cushing 1920:298, 595; Mindeleff 1891:163–164; Stevenson 1904:363). This brief list of corn preparation options is by no means complete, particularly if one were to add specific ways to cook each of the many varieties of corn and the corn dishes prepared with various other plants and meats.

Processing corn kernels with alkali—by using lime, wood ash, or lye—is mentioned frequently in ethnographic accounts. In an important paper about maize-based cultures, Katz et al. (1974:773) argue that without alkali treatment high corn consumption results in malnutrition. Corn is naturally low in the amino acids lysine and tryptophan as well as niacin. Alkali and heat treatment ameliorates these deficiencies by improving the amino acid balance of corn and freeing niacin (Katz et al.:766–767). The authors conducted a worldwide study of 51 societies recorded in the Human Relations Area Files to determine how commonly alkali cooking techniques were used for maize. They found that

... there is a striking almost one-to-one relationship between those societies that both consume and cultivate large amounts of maize and those that use alkali treatment. On the other hand, those societies consuming and cultivating smaller quantities of maize almost invariably do not use alkali cooking techniques. (Katz et al. 1974:770).

Sophie Coe (1994:14–15, 146–147), in her informative book on native Mesoamerican cuisine, also emphasizes the nutritional importance of alkali treatment of corn. The maize grains are soaked and then cooked with lime or wood ashes. This removes the skin of the kernels, makes them easier to grind, and enhances the protein value of the maize. Similarly, Bennett and Zingg (1935:33–34, 76) write that among the Tarahumara of northern Sonora, alkali treatment is an essential corn preparation technique. The corn is boiled in an olla in oak ashes. These kernels then can be eaten without grinding, as hominy, or ground on three metates to produce dough for tortillas. A stew is made of corn boiled with lye and beans and meat and salt. The ethnographic cultures in the Katz et al. study (1974:769) include the Zuni and Tewa Pueblo groups, who treat their corn with both ashes and lime (see also Cushing 1920:293–294; Stevenson 1904:362–367). Almost certainly such widespread Native American techniques for the alkali treatment of corn go back into prehistory.

**RECTANGULAR SLAB-LINED HEARTHS AND THE INTENSIFICATION OF MAIZE AGRICULTURE**

By 1300 A.D. RSL hearths had replaced CCL hearths as the major cooking hearths in the Grasshopper region. Table 3 shows that CCL hearths decrease in importance from Grasshopper Spring, where they represent 42% of the fire features, to Chodistaas, where they represent 38%, to Grasshopper, where they represent just 18%. At Grasshopper Spring Pueblo circular clay-lined hearths are the major household hearths and rectangular slab-lined types are completely absent (Lowell 1995). Chodistaas is transitional in its use of fire features, with rectangular slab-lined hearths appearing late in its occupation. At Grasshopper Pueblo RSL hearths became the most common type. The CCL and RSL hearths are rarely found in association with each other, showing a mutual exclusivity that bolsters the hypothesis that CCL hearths were the main cooking hearths earlier in time and RSL hearths were the main cooking hearths later.

The introduction of RSL hearths is
linked to the increased commitment to maize agriculture documented for the Grasshopper region and particularly to a new emphasis on ground maize. As discussed above, the RSL hearths at Grasshopper have the greatest association with manos and metates and, in contrast to CCL hearths, correlate significantly with mealing bins. Researchers have noted that different maize-processing techniques are reflected in different grinding tools (Doebley and Bohrer 1983:35). Mealing bins are generally used with long manos and flat metates. Since more surface is covered with each stroke, more corn can be ground in less time by using this grinding system than by using short manos with basin or trough metates (Adams 1993). Thus the increased use of mealing bins indicates an increase in the intensity and efficiency with which corn was prepared. Of course, mealing bins are not always in the same space as their related hearths. In some Pueblo sites mealing rooms are generally without fire features, and communal grinding is inferred (see Mobley-Tanaka 1997). At Grasshopper some rooms have RSL hearths with mealing bins, some have RSL hearths without bins, and a few have just bins. This may indicate some communal grinding or simply the organization of some houses such that the mealing bin is in a different room from the RSL hearth (Ciolek-Torrello 1985:55).

At Grasshopper 55% of RSL hearths have associated hammerstones and these artifacts also may relate to grinding corn. They can be used to break up kernels for grinding (Brooks 1993:184) or to reshape grinding equipment (Schlanger 1991:462). The arrival of new people with different food-processing technologies, along with the need to provide food for large numbers as the population soared, may have encouraged the elaboration of corn preparation.

Is there evidence for boiling corn with alkali solution in the Grasshopper region? At Grasshopper, 26.2% of the RSL hearths had ash pits in association, whereas only 15.4% of CCL and CU hearths did. Exactly why these people saved their ashes rather than threw them outside has never been explained. One possible answer is that they were storing the ash for alkali cooking. Other containers, including pots and baskets, could also have been used for ash storage.

How does the RSL hearth itself enhance corn processing? The ethnographic accounts demonstrate that cooking by boiling is crucial for corn dough preparation, both to prepare the kernels for grinding and for cooking already-ground corn as mush or gruel or in stews. The form of the RSL hearth is particularly efficient for lengthy boiling with pots. First, the slabs provide built-in supports for pots so they can sit for long periods over the fire. When pots are placed over other types of hearths, they must be hung over the fire or propped up with portable stones. Second, the fire will not be smothered by the pot because the circular shape of the pot over the rectangular shape of the hearth, allows air in around the corners. Circular fire features, even those with raised clay ridges, need the addition of pot rests to support the pot while allowing for air circulation. Third, the rectangular form of the fire leaves it partly open allowing it to be fed with fresh wood.

If this slab-lined fire feature is so practical for pot boiling, why is it uncommon in ethnographic accounts? One possibility is that the ethnographically popular method of cooking dough on a griddle, for tortilla-type breads, would simply not work over a four-sided slab fire feature, because the fire would be quickly smothered by the griddle (see Adams 1991:82). Two solutions to the problem of griddle cooking appear in the ethnographic record. The first uses portable stones which can support either a griddle (Bennett and Zingg 1935:33; Coe 1994:146–147; Kluckhohn et al. 1971:127–128) or a boil-
ing pot (Buskirk 1986:202; Kluckhohn et al. 1971:129; Spier 1933:78) without smothering the fire. The more permanent solution is to set up two parallel stone slabs, or three slabs in a U-shaped formation, and place the griddle on top. One or two sides of this fire feature are thus left open for ventilation and feeding the fire. The Hopi and Zuni system for cooking wafer bread on stone griddles includes these slabbed fire features (Adams 1991:82; Cushing 1920:317–343; Mindeleff 1891:175–176; Stevenson 1904:1904:361–362). I suggest that they are modified RSL hearths, with one or two slabs removed. The earliest archaeological evidence for stone griddles is in the late 1200s at Homolovi in the middle Little Colorado region (Adams 1991:81–82) and the Hopi trace their ancestry to this region. The ongoing work at the Homolovi sites could shed light on fire-feature changes that might have accompanied the appearance of stone griddles.

Given the absence of either ceramic or stone griddles at Grasshopper, the corn dough here was probably used in various stews and gruels rather than for griddle cooking, and the four-sided RSL hearth worked well for these purposes.

RECTANGULAR SLAB-LINED HEARTHS ACROSS THE PREHISTORIC PUEBLO REGION

What does the archaeological record outside of the Grasshopper region tell us about the hypothesized relationship between RSL hearths and increased reliance on corn? A look at a selection of well-documented sites indicates that RSL hearths appear at different times in different regions of the prehistoric Pueblo area. Their earliest regular use is among certain of the Mogollon. Very broadly, early pit-house villages of both the Mogollon (Haury 1936, 1985; Olson 1959:482) and Anasazi traditions (Cordell 1984:102) have circular hearths. These may be unlined or lined with clay or stones. Fire features in early Mogollon Pueblo villages, meaning those with above-ground rooms sharing walls, vary. They may be circular or rectangular or a combination. When both types are present, the rectangular features tend to be found in the larger rooms.

Patricia Gilman’s architectural study (1987) indirectly sheds light on fire-feature forms. She analyzed cross-cultural data and demonstrated that transitions from pithouse-to-pueblo-style architecture correlate with increasing dependence on agriculture and sedentism. If agricultural reliance is on grains, food preparation becomes more time consuming in both grinding and cooking. Improved storage systems are also necessary. In pueblo sites storage rooms are common, and such above-ground storage is best for the long term, since below-ground storage is more susceptible to dampness and pests.

I suggest that, like the architectural shift from pithouse to pueblo, the shift from circular to RSL hearths reflects an increased dependence on maize agriculture. In parts of the Mogollon region, RSL fire features appear very early and concurrently with the pithouse-to-pueblo transition. Large Classic Mimbres sites that date from about 1000 to 1150 A.D., including Swartz (Cosgrove and Cosgrove 1932) and Nan Ranch (Shafer 1982), have RSL hearths as standard features in the larger rooms. The RSL hearths in this region also tend to have associated slab-lined ash bins (Plog 1997:88), implying alkali treatment of maize. Two late pithouses at Swartz Ruin have rubble masonry walls, indicative of a gradual transition to pueblo architecture. These transitional pithouses are also transitional in their fire features, since they have both CCL and RSL hearths. Some early Mogollon pueblo sites in other areas also have RSL hearths. At Tla Kii (900–1100 A.D.), a ruin of some 21 rooms in the Forestdale Valley of east-central Arizona, eight RSL hearths and seven CCL hearths were excavated.
(Haury 1985). However, other early Mogollon sites from this period have no RSL hearths. These include the South Leggett and Wet Leggett sites (Martin and Rinaldo 1950). These smaller sites may have been seasonally occupied hamlets where intensive maize processing was not done.

By the 1200s A.D., the popularity of RSL hearths increased and they were common over a greater area. They occur in the larger rooms at Broken K Pueblo in the Hay Hollow Valley. Here they are clearly associated with mealing bins (Hill 1970) that indicate intensive grinding. Turkey Creek Pueblo in the Point of Pines area of east-central Arizona has a mix of circular and rectangular hearths, but with a variety of linings for each (Lowell 1991). At this site, rectangular fire features tend to be found in the larger rooms, circular fire features in the mid-sized rooms, and no fire features in the smallest rooms (presumably storage rooms).

The RSL hearths appear later among the Anasazi than among the Mogollon. They are present but not common in the San Juan Anasazi area, which was abandoned before 1300 A.D. They are not standard room features in Chaco Canyon (Lekson 1984; McKenna and Truett 1986; Vivian and Mathews 1973) or in the Mesa Verde Region, as determined by the well-documented sites of Big Juniper House (Swannack 1969) and Mug House (Rohn 1971). If the Coombs site (Morgan 1994:94–96) is representative, they are not typical of early Kayenta Anasazi sites either. However, they do become common among the Kayenta by the late thirteenth century, as documented at Betatakin (Dean 1969) and Antelope House (Morris 1986).

In sum, RSL hearths spread gradually across the prehistoric Pueblo cultures. They appear earliest among some Mogollon groups in the more southern regions of Pueblo cultures. They occur as early as the transition from pithouse- to pueblo-style dwellings around 1000 A.D. and are concurrent with an increased commitment to agriculture. Although they are present in the Northern Anasazi region prior to 1200 A.D., they are not standard features until the late thirteenth century, by which time they are popular among the Kayenta Anasazi. By the fourteenth century the RSL hearth is common and widespread throughout the Pueblo region. It is found, for instance, at Grasshopper and Point of Pines Pueblos (Haury 1958:416) in the Mogollon Mountain region, at Homolovi II (Madsen and Hays 1991) on the Colorado Plateau near Winslow, and at Arroyo Hondo Pueblo (Creamer 1993) in the Rio Grande area. At some point in the late prehistoric or early historic period, the RSL fire feature became eclipsed by other forms. As discussed above, the growing popularity of griddle cooking of tortilla like breads may have made the RSL hearth obsolete.

**FIRE FEATURES AND THE ORGANIZATION OF SUBSISTENCE ACTIVITIES**

The changes in fire-feature patterning in the Grasshopper region reflect not only the new subsistence emphasis on ground maize, but also changes in social organization that were required by expanded communities with year-round sedentism and intensified agriculture. Because fire features are linked to activities carried out by various large and small groups within a community, they carry information about the organization of that community for subsistence and other activities. Most notably, formalized fire features constructed and used by units larger than households are more apparent at Grasshopper Pueblo than at Grasshopper Spring and Chodistaas and suggest increased cooperation among households.

**Household-Level Fire Features: CCL, RSL, and CU Hearths**

Households are the primary organizational units in any settlement. Households
are defined here as the primary units of consumption (Goody 1972). They are most clearly reflected in the archaeological record by the identification of the cooking hearths used to prepare regular household meals (Lowell 1991). Since household units are the most numerous social unit and food preparation is a major activity of households, they have the most numerous fire features. Because of the shift toward an increased use of ground maize in the Grasshopper region, households of the late thirteenth century are defined by circular clay-lined hearths, but those of the early fourteenth century, by rectangular slab-lined hearths, which are associated with numerous grinding tools. The circular unlined hearth is a casually constructed fire pit providing heat and light for households and other groups in both exterior and interior locations.

Suprahoushold-Level Fire Features: Roasting Pits, Individual Ovens, Oven Sets, Ceremonial Hearths

Other fire-feature types are used by suprahousehold units. These are loosely defined here as social units larger than households, but smaller than the total aggregated village of Grasshopper Pueblo. They may or may not be kin based. A number of different kinds of suprahousehold units were active at Grasshopper, but they are not easy to differentiate from each other in the archaeological record. Still, an examination of the fire-feature patterning enhances understanding of them by highlighting certain subsistence and other activities that are carried out by groups other than households.

Roasting pits are large and relatively small in number, suggesting use by units more inclusive than households. Furthermore, they are usually outside, in public areas, indicating that they may not be claimed by particular households. If the inference that these features were used to cook meat is accurate, then at least some meat was shared among households (see Wandsnider 1997). Also, consistency through time in the use of roasting pits may reflect continuity in the way meat was shared by social units throughout the thirteenth and fourteenth centuries. This is the only suprahoushold feature found both early at Grasshopper Spring and Chodistaas and later at Grasshopper Pueblo. Roasting pits are common ethnographically and are used for cooking a variety of foods, including meat (Buskirk 1986:149; Kluckhohn et al. 1971:130–132; Lumholtz 1902:42), agave (Bennett and Zingg 1935:148; Buskirk 1986:170–173; Castetter and Underhill 1935:15–16; Spier 1933:152–155), and cholla buds (Castetter and Underhill 1935:15–16; Spier 1933:152–155).

Communal fire-feature types increase with the organizational requirements of aggregation at Grasshopper Pueblo. In particular, the ovens and ceremonial hearths, both of which are distinctive and carefully constructed features, point to intensified and formalized cooperation within suprahousehold units.

The ovens were probably used for cooking a variety of foods, but were specialized for corn. The whole cobs and kernels recovered from them point to a task that is necessary to communities that are reliant on maize and is well-documented ethnographically: the large-scale roasting of newly harvested corn in preparation for winter storage. As needed through the winter, kernels can then be removed from the stored cobs, treated with alkali solution, and ground for dough to be used in various mushes and breads. Cushing (1979:275–277) vividly describes the festive cooking of corn-on-the-cob among the Zuni at the end of the harvest. This was done in the fields in large bell-shaped roasting pits, where the corn was baked all night (see also Stevenson 1904:367). The Grasshopper ovens are an elaborate version of the corn-roasting ovens documented in the ethnographic record.
Since Grasshopper Pueblo is itself surrounded by agricultural land (Welch 1996:68), its corn-roasting facilities are located right at the pueblo and are permanent structures.

At Grasshopper Pueblo one set of three or more ovens is associated with each of the three major room blocks. Several characteristics of the individual ovens indicate use by units larger than households. They are enormous in size, few in number compared to the RSL (household) hearths, and have exterior public locations that show no proximity to individual houses. I argue that the individual ovens are linked to one type of suprahousehold group, and the oven sets to a yet more inclusive group, the room block itself. Thus, corn roasting at Grasshopper took place at a suprahousehold but subroom-block level. The masonry walls kept whatever was cooked in one oven carefully separated from what was cooked in the other attached ovens. It follows that planting, harvesting, and thus field ownership also may have involved this particular level of cooperation.

The precise membership of the oven groups is impossible to determine archaeologically, but lineage or clan control of particular fields has ethnographic parallels (Eggan 1950:62, 110) and is certainly a possibility for the fields and ovens of Grasshopper. The numbers of rooms associated with the oven groups suggest that these social units might be isomorphic with earlier villages, which, in turn, might or might not have consisted of related households. Room Block 2 has 92 rooms and a line of 5 ovens, or roughly 18 rooms per oven. Eighteen rooms are too many for one household, but could be used by a group of related households with several rooms each. It also is a reasonable number for a small hamlet, like Chodistaas, which had exactly 18 rooms. If earlier villages moved as units to Grasshopper Pueblo, they might have claimed certain agricultural land for their use and built an oven for roasting their harvests.

On the other hand, there is no evidence for storage space shared by groups larger than households. The small storage rooms are more numerous than the ovens and are scattered, suggesting linkage with individual households rather than larger units. Therefore, storage, along with daily corn preparation using the RSL hearths, took place at the level of the individual household. Once the corn was roasted in the ovens, it may have been allocated for storage to the individual households within the supr ahousehold groups that controlled the fields and ovens. Alternatively, each household within an oven group might have roasted its own harvest in succession. In this case, the land of the oven group may have been subdivided by household, along the lines of the traditional Hopi system, where clans own land and households within a clan are allocated certain fields according to their needs (Eggan 1950).

The three oven sets were constructed with shared walls, as were the houses themselves. This points to cooperation at the level of the total room block, at least in initial oven construction, but independence of the units that controlled the individual ovens, fields, and crops. One can imagine harvest time at Grasshopper Pueblo. Huge quantities of corn would be roasted in the ovens. There would be room-block or villagewide feasting and celebration, probably in the plazas and Great Kiva. However, the corn not consumed in feasting, and belonging to each group, was painstakingly kept separate in the individual ovens.

These multiple levels of organization for food harvesting, storage, and preparation apparently broke down toward the end of the occupation of Grasshopper Pueblo. The population decreased, people dispersed, and small household groups used the site perhaps on a seasonal basis.
(Reid 1989). The set of ovens in Room block 3 was covered by a late room, pointing to less cooperation in maize harvesting and processing later in time.

While not directly related to subsistence activities, the ceremonial hearths, like the ovens, indicate elaboration of suprathousehold units concurrent with aggregation and intensified agriculture at Grasshopper Pueblo. These features provide heat and light in ceremonial rooms and kivas. Kivas are identified by ceremonial hearths, along with low numbers of food-processing tools and benches. Ceremonial rooms are similar in their hearths and tools, but lack benches. According to Reid and Whittlesey (1982:697, 1997:159), ceremonial rooms are shared by about three households, and Kivas, which are fewer in number, are shared by about six households. Whether or not the groups using the ceremonial rooms and kivas are kin based is impossible to say. In Whittlesey's analysis of mortuary data (Reid and Whittlesey 1997:159; Whittlesey 1978), she argues that several different men's societies existed at Grasshopper Pueblo. These may have been the groups that used the ceremonial rooms and kivas. If membership in these societies crossed kin groups, they would have helped forge ties among potentially competitive kin groups, thus strengthening the unity of the community (see Egan 1950:117). On the other hand, the ceremonial room units, the kiva units, or both might be identical with other suprathousehold groups, notably the oven groups. There is no evidence to support or refute these various possibilities. However, that these ritual units, whatever their configuration, carried out activities other than food preparation around their special ceremonial hearths seems clear. Yet their duties were at least indirectly related to subsistence through the organizational needs of a large agricultural community that is occupied year-round.

The ceremonial units appear to have roots in the thirteenth-century hamlets. These sites have rooms with platforms that are interpreted as protokivas. There are two such rooms at Chodistaas and one at Grasshopper Spring. Their primary fire features are circular clay-lined hearths that stand out only because they are particularly well made. The single roasting pit at Grasshopper Spring also is in its protokiva. At Grasshopper Pueblo the ceremonial hearths take a unique form, implying formalization and intensification of the ceremonial levels of organization with aggregation.

Village Level: No Distinctive Fire Features

Initially, Grasshopper Pueblo had three main room blocks and three plazas. These architectural units may have been settled by three separate groups (see Reid 1989). The three sets of ovens support the view that there is some social reality to the three architectural units. Sometime later, around 1330 A.D., the RB 2 plaza was converted to a villagewide Great Kiva (Reid and Whittlesey 1997:161). This building project highlights the perceived need for strengthening unity at the level of the total village. However, no distinctively styled central hearth is associated with this kiva. In contrast, great kivas elsewhere, as at Chaco Canyon (Vivian and Reiter 1965), often have large fire features of unusual forms. Dispersion to other sites in the region and regional abandonment began soon after the construction of the Grasshopper Great Kiva (Reid 1989). It appears that at Grasshopper, cooperation at the total village level was ephemeral.

In sum, the varied fire features of Grasshopper Pueblo at its peak of aggregation around 1330 A.D. suggest new organizational systems related to the need for cooperation among a large group of people coping with aggregation and new subsistence needs and practices. Prior to this aggregation, there are fewer types of fire features and these were more general in function. With aggregation at Grasshopper, the fire features became both more varied and
more specialized for different kinds of food preparation and ceremonial activities. They also are linked to an increase in the number of cooperating subunits of the society. The fire features of Chodistaas and Grasshopper Spring are primarily household features, with only the roasting pit and the well-made CCL hearths of the protokivas indicating cooperation above the household. In contrast, the ceremonial hearths, ovens, and oven sets of Grasshopper Pueblo reflect an increase in the numbers and kinds of supra-household units and the reinforcement of cooperation within them. The total village unit, however, seems weakly united, as suggested by the late construction of a Great Kiva, the lack of an elaborate fire feature there, and the disintegration that began shortly after the kiva was constructed. The aggregated system at Grasshopper Pueblo broke back down into smaller units centering on households or small combinations of households before abandonment of the region.

CONCLUSIONS

Around 1300 A.D. marked changes occurred in the Grasshopper region of Arizona. New people flocked to this mountain area, aggregated into large communities, and increased their commitment to maize agriculture and year-round sedentism. I have used this well-studied region to demonstrate that fire-feature patterning responds to such cultural transformations and enhances our understanding of them. First, since food-preparation techniques vary with the foods cooked, subsistence practices clearly are tied to fire-feature types. In the Grasshopper region the shift from a household focus on circular clay-lined hearths to one focusing on rectangular slab-lined hearths is linked to the increased subsistence concentration on ground maize. The RSL hearths are particularly useful for boiling, since the slab sides provide built-in pot support. Boiling, generally involving alkali treatment, is a crucial part of the process of preparing maize dough used by people reliant on maize as a staple food. The masonry ovens also point to the increased centrality of maize agriculture and sedentism. They were most likely used for roasting fresh corn-on-the-cob at harvest time. Some of it would have been eaten right away, probably as part of a harvest feast, but the bulk would have been stored for use through the winter. Second, since group activities often require heat, light, or food, social organization is linked to fire-feature patterning. At Grasshopper Pueblo the introduction of carefully constructed communal types (ovens, oven sets, and ceremonial hearths) is concurrent with aggregation into a large community that required new systems of integration to ensure the cooperation of large numbers of people for subsistence and other activities.

Fire features are ubiquitous and variable features of the archaeological record that offer insights unavailable from other kinds of data. The Grasshopper case demonstrates that fire features respond quickly and dramatically to shifts in human subsistence behavior and in the social organization required by such changes. An increased understanding of fire-feature patterning worldwide will help archaeologists elucidate both subsistence systems and social organization and changes in these dimensions of human behavior.

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