Sources of Igneous Temper for Fremont Ceramics of South-central Utah

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Abstract. To delineate production zones for Fremont pottery of south-central Utah, we identified the geologic sources of the igneous rock used to temper the pottery produced in the region. Igneous inclusions were first classified into a series of temper types based on mineral and textural differences perceived under low-power (×30) magnification. The types were then visually correlated with igneous rock samples collected from various geologic formations of south-central Utah. Subsequent petrographic analysis confirmed these correlations and allowed us to describe the mineralogy of the temper types. We provide an initial basis for differentiating general production zones of Fremont pottery from south central Utah, and indicate the need for rethinking the existing classification of Fremont pottery.

Key words: Ceramic production, ceramics, Fremont, Utah prehistory.

Glen Canyon (Fig. 1) marks the southeastern extent of Fremont pottery distribution. During the Glen Canyon Project of the late 1950's and early 1960's, sherds identified as the Fremont types Emery Gray and Snake Valley Gray were recovered from numerous sites, especially in the Escalante River basin (Fowler et al. 1959; Lister 1964). Thus it was no surprise that Fremont pottery was frequently found during a recently completed 5-year survey project in the Glen Canyon National Recreation Area conducted by the Archaeology Laboratory of Northern Arizona University (NAU). The Fremont pottery found during this project was easily distinguished from Anasazi and Shoshonean wares, and it was equally easy to separate Fremont sherds according to two basic temper inclusions—quartz and igneous rock. The existing Fremont pottery classification provides two categories for igneous-tempered sherds—Emery Gray or Sevier Gray (Madsen 1977). Sorting sherds into these categories based on the published type descriptions proved diffi-

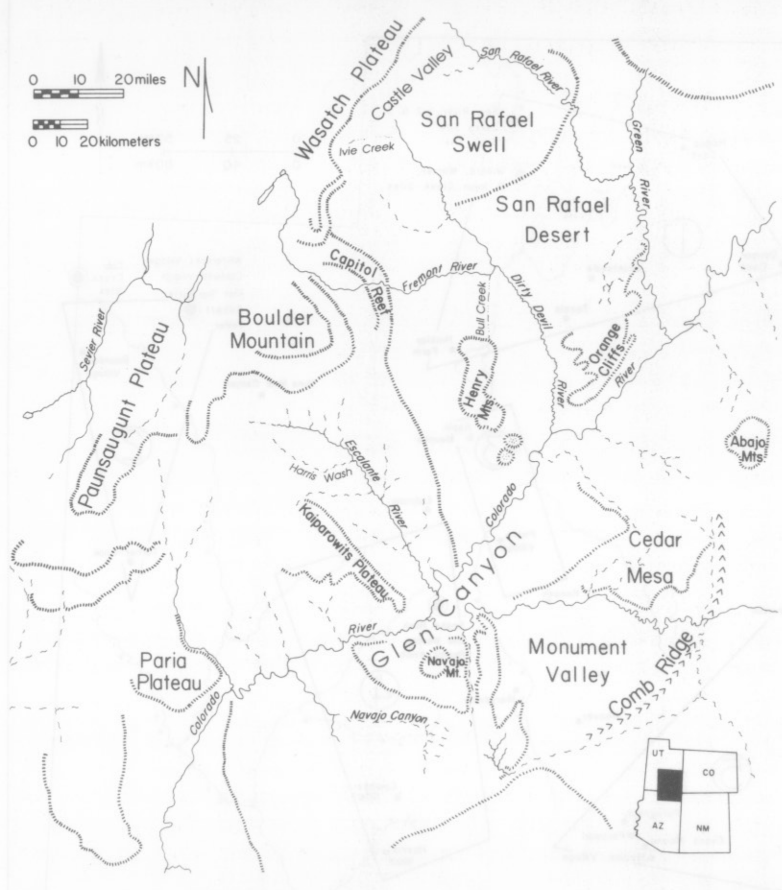

Fig. 1. Location of the study area.

cult, a problem noted by others working with Fremont pottery (Ambler 1966:239; Madsen 1970:74; Hauck 1979:308). There seemed to be far more diversity in the igneous inclusions than could be accounted for by the two type descriptions. Even more disconcerting, a majority of Fremont sherds collected during the NAU survey were tempered with what appeared to be black basalt. This seemed to correspond to the temper description of Sevier Gray, but the implication that this material was trade ware seemed dubious. Figure 2, which depicts Madsen's (1970) core production areas for various Fremont ceramic types, shows that the Sevier Gray core area (number 3) is located a considerable distance from Glen Canyon. Furthermore, the vast majority of Fremont pottery recovered during earlier research in Glen Canyon was identified as Emery Gray (Fowler 1963:40; Lister 1964:8). Indeed, these earlier type identifications led to the southward extension of the Emery

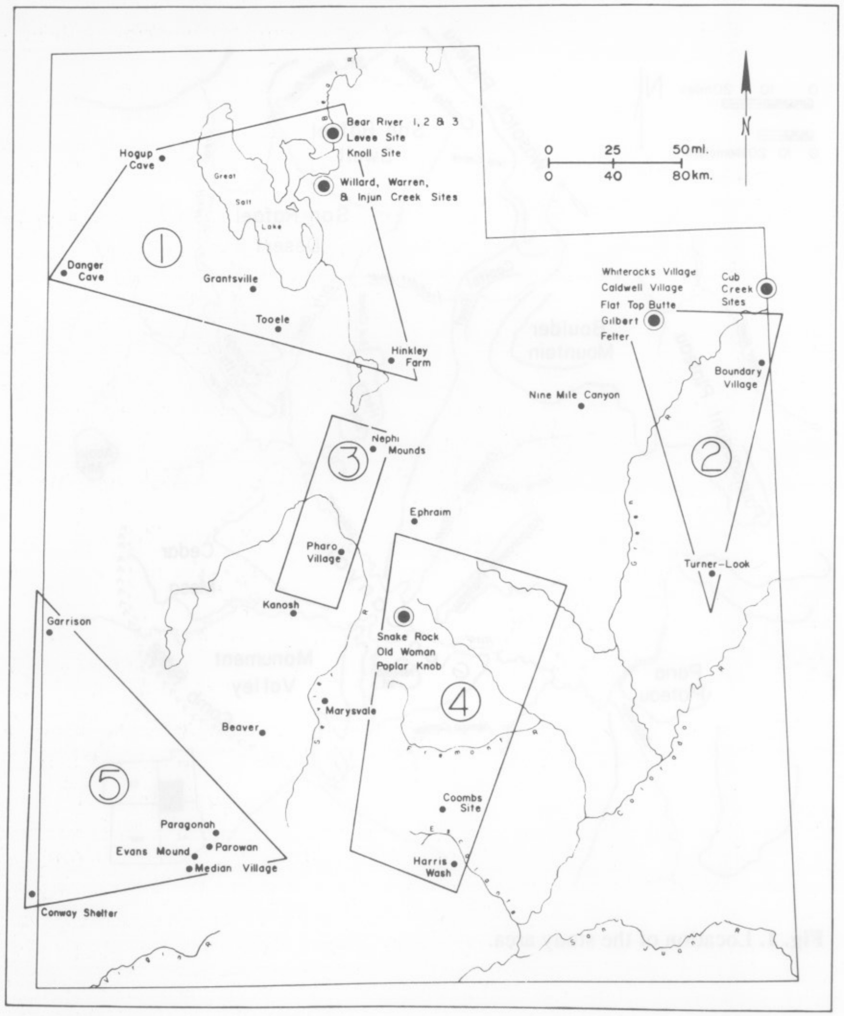

Fig. 2. Fremont Gray ware core production areas according to Madsen (1970, Fig. 50): *1* = Great Salt Lake Gray, *2* = Unita Gray, *3* = Sevier Gray, *4* = Emery Gray, *5* = Snake Valley Gray (Figure 142 from Jennings 1978).

Gray production zone to include the Escalante River basin (number 4 in Fig. 2) where Emery Gray was reported to be relatively abundant. To help sort out some of these classificatory ambiguities and reveal possible production zones for the Fremont ceramics found in Glen Canyon, we initiated a compositional analysis of igneous-tempered Fremont pottery. Petrographic analysis and geologic sourcing of tempers are important components of this study and will be reported here. We anticipated that this work might shed light on Fremont ceramic production in south-central Utah, as well as provide an important comparative data base for other researchers working with Fremont ceramics.

Classification of Igneous Tempers

As a first step, all Fremont ceramics collected during NAU's 5 years of survey in Glen Canyon were examined along fresh breaks under a ×30 binocular microscope to identify their aplastic inclusions. Two major temper groups were observed for the sample of Fremont pottery from Glen Canyon—igneous rock and quartz in a micaceous paste. Our concern here is with the igneous group. To increase the sample size and expand the spatial coverage for comparative purposes, other ceramic collections were analyzed in like fashion. Included were ceramics from excavated sites in Harris Wash (Fowler 1963) and a few other drainages of the Escalante River basin (Gunnerson 1959); from several of the sites along Bull Creek at the northern foot of the Henry Mountains (Jennings and Sammons-Lohse 1981); and from two Fremont sites of the San Rafael Swell area—Snake Rock along Ivie Creek (Aikens 1967) and Windy Ridge in Castle Valley (Madsen 1975).

Aplastic inclusions were classified according to a series of temper categories created after the range of temper variability in Fremont pottery of the region was determined by preliminary examination of NAU's collections and type sherds housed at the Utah Museum of Natural History, University of Utah. Discussions with Lane Richens of Brigham Young University were helpful.

Under a ×30 microscope, there are obvious visual differences in groundmass and phenocrysts among the temper categories. Four of these categories, simply labeled A–D, are common in Fremont pottery of Glen Canyon and seemed likely to be discrete rock types. Type A has a black to dark gray groundmass and prominent, clear and dark-green-to-black phenocrysts; B has a gray, aphanitic, and mattelike groundmass with sparse but distinctive biotite phenocrysts and more abundant clear phenocrysts. Type C has a felsic microcrystalline groundmass flecked with tiny black particles and containing common, dark green to black phenocrysts; D has a whitish, finely granular groundmass and common black amphibole phenocrysts with a well-defined crystal structure.

A fifth temper category (E) was recognized as another possible discrete rock type. Temper category E is essential to our discussion, though it is apparently a rare occurrence in south-central Utah. This category consists of a glassy, microvesicular black igneous rock easily distinguished from the black igneous rock of temper category A. Category E occurs in a distinctive dark brown micaceous paste and, according to Lane Richens (Brigham Young University, Provo, personal communication 1989, 1990), is common to the Sevier region of west-central Utah.

The temper analysis results were grouped according to three geographical areas that partition the data base to reveal spatial patterning in the representation of temper categories (Fig. 3). From south to north, these areas are the Escalante River basin (including lower Glen Canyon), the Henry Mountains (including Bull Creek and upper Glen Canyon), and the San Rafael Swell (Ivie Creek–Castle Valley).

The most noticeable trend in the data is the inverse relation between temper categories A and C. In the Escalante River basin sample, category A occurs in 58% of the sherds, whereas in the San Rafael Swell sample it occurs in only 2%. In contrast, temper category C occurs in about 4% of the sherds from the Escalante River basin sample, but almost 70% of the sherds from the San Rafael Swell sample. Temper category B only occurs in sherds from the Escalante River basin sample, whereas temper category D only occurs in the Henry Mountains sample.

While conducting the analysis, additional temper categories were created to accommodate apparent mixtures of the four categories and completely distinctive igneous inclusions (all but one of these additional categories are lumped together in Fig. 3 under Other). Most numerous is a combination of temper categories A and C, which is more common in the north, increasing from 15% in the Escalante River basin sample to 25% in the San Rafael Swell sample. A common combination in the Escalante River basin is A and B; a few complex mixtures were observed in the Henry Mountains sample including sherds that appeared to contain A, C, and D, and perhaps another igneous rock as well. Also lumped in with Other are a few sherds of temper category E, the microvesicular black igneous rock common to the Sevier region. Less than 1% of the entire sample is of this distinctive category.

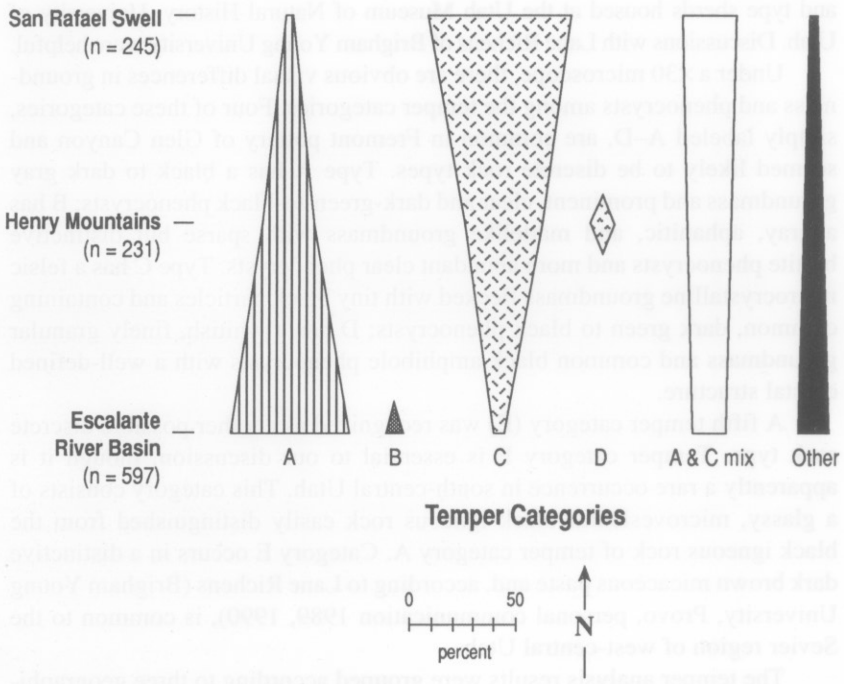

Fig. 3. Representation of igneous temper categories in Fremont pottery from three areas of south-central Utah.

Potential Geologic Sources

Next we tried to identify specific geologic sources for at least the principal temper categories (A–D). Most bedrock of south-central Utah is sedimentary—shown in Fig. 4 as white. Igneous rocks are largely confined to the western margin; exceptions include the Henry Mountains laccolith and a scattering of minor sills and dikes. The geologic units of this region are mapped and described on the Escalante and Salina 1:250,000-scale geologic quadrangles (Williams and Hackman 1971; Hackman and Wyant 1973). These quadrangles served as guides for an extensive sampling project. Sampling was conducted after thorough visual familiarity with the various igneous rocks used to temper Fremont pottery of the study area. Two trips were made to collect igneous rocks from outcrop and secondary deposits across a region extending from the Aquarius Plateau on the south to Ivie Creek on the north and from Otter Creek on the west to the Henry Mountains on the east.

Multiple samples were gathered for each major igneous unit of interest, especially those that are spatially extensive and could have been widely used as temper sources. This was important for monitoring textural and mineralogical variability in the igneous rocks. No claim is made that this was an exhaustive sampling program; however, it proved informative and provided a solid foundation for further studies of igneous temper sources.

To facilitate visual comparisons between the rock samples and the temper categories, fractions of the rock samples were crushed and sieved into three size classes (<1 mm, 1–2 mm, and >2 mm). The crushed rock was then added to clean clay and formed into sample sherds that were kiln fired. After microscopic comparison of the igneous inclusions in these modern sherds and the prehistoric sherds, certain igneous units emerged as likely sources of specific temper categories. We will use the map designations of these igneous units for this discussion.

Tba—a basaltic andesite with a dark glassy groundmass and prominent phenocrysts of plagioclase and pyroxene—seems a certain match with temper category A. Tlo—a latite tuff with a gray groundmass, abundant feldspar phenocrysts, and sparse biotite phenocrysts—is visually identical to temper category B. Tla consists of several igneous rock types (basaltic andesite and tuff) that were not differentiated by Williams and Hackman (1971). One of the components of Tla is a gray basaltic andesite, similar to or the same as temper category C. Tdp—a diorite porphyry with a whitish plagioclase groundmass containing a profusion of black amphibole phenocrysts—is indistinguishable from temper category D.

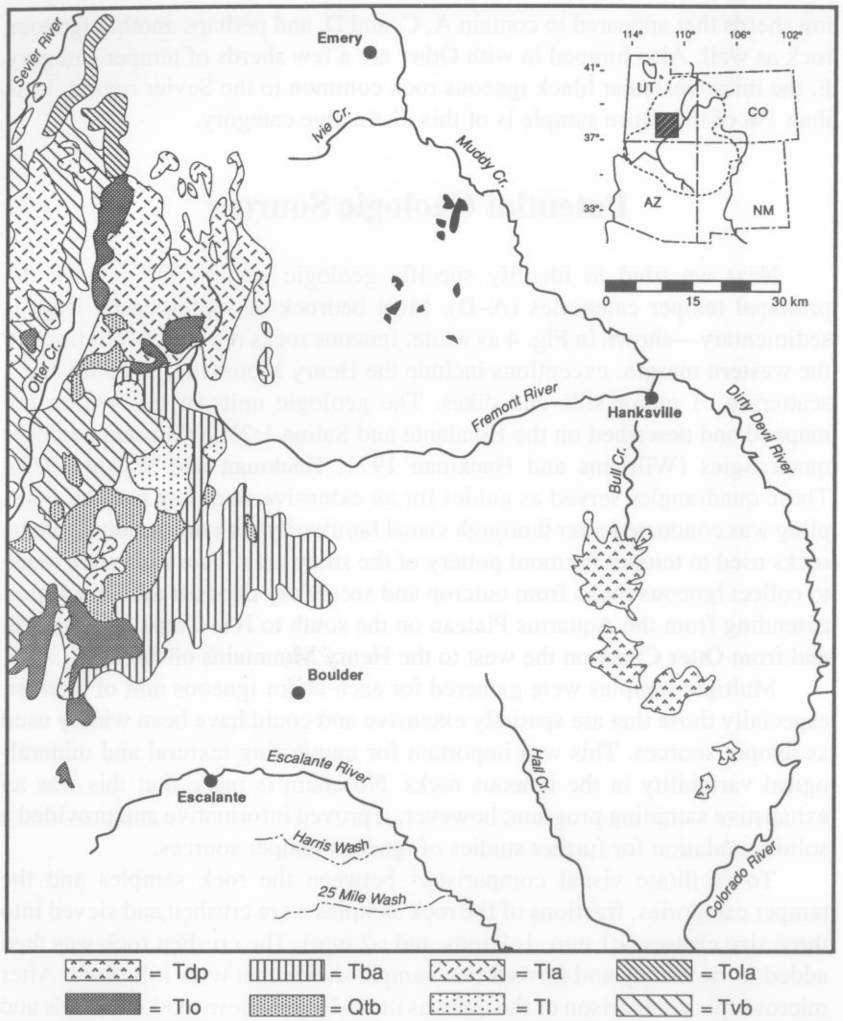

Fig. 4. Igneous units exposed in the study area. *Unshaded portions* are sedimentary rock; *small black areas* are intrusive sills and dikes (based on Hackman and Wyant 1973 and Williams and Hackman 1971).

A few of the mapped igneous units, such as Qtb, an olivine basalt, apparently were not used as temper—at least, they did not match any temper in the sherd sample. No igneous rock was found that appeared identical to temper category E despite a concerted effort to locate potential matches. The few rock samples that approximated category E in texture and color were later found to be substantially different based on petrographic analysis (see below).

A clear relation exists between where certain igneous units outcrop and the proportional representation of igneous temper categories (Fig. 5). Temper

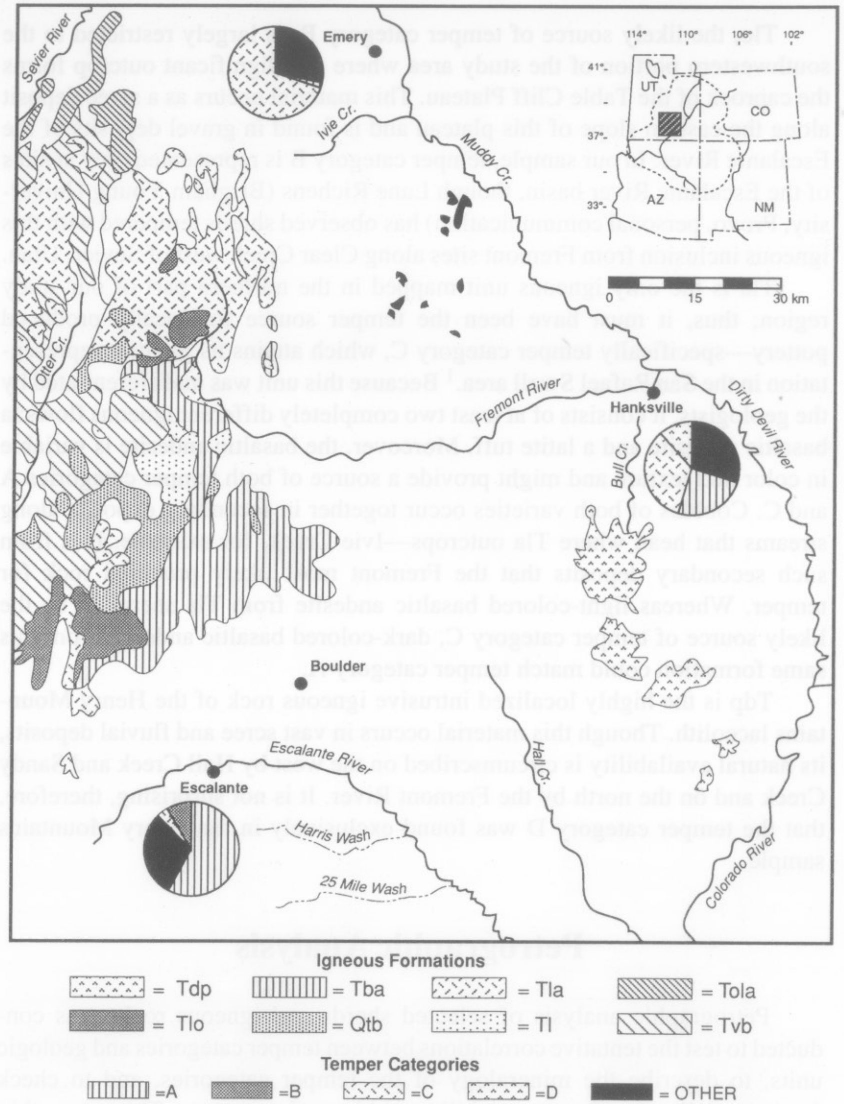

Fig. 5. The relation between where certain igneous units outcrop and the proportional representation of temper categories. The category *Other* is largely made up of sherds with a mixture of inclusions of both categories A and C.

category A is predominant in the Escalante River basin; this is where its apparent source, Tba, is represented. This material caps Boulder Mountain and forms vast scree deposits along its eastern and northern slopes. Cobbles of it also occur in fluvial deposits of the Escalante and Fremont rivers. Secondary deposits of Tba along the Fremont River probably account for the relatively high proportion of temper category A in the Henry Mountains area.

Tlo, the likely source of temper category B, is largely restricted to the southwestern portion of the study area where one significant outcrop forms the caprock of the Table Cliff Plateau. This material occurs as a scree deposit along the eastern slope of this plateau and is found in gravel deposits of the Escalante River. In our sample, temper category B is represented only at sites of the Escalante River basin, though Lane Richens (Brigham Young University, Provo, personal communication) has observed sherds tempered with this igneous inclusion from Fremont sites along Clear Creek west of Sevier, Utah.

Tla is the only igneous unit mapped in the northern part of our study region; thus, it must have been the temper source for locally produced pottery—specifically temper category C, which attains its greatest representation in the San Rafael Swell area.[1] Because this unit was undifferentiated by the geologists, it consists of at least two completely different igneous flows: a basaltic andesite and a latite tuff. Moreover, the basaltic andesite is variable in color and texture and might provide a source of both temper categories A and C. Cobbles of both varieties occur together in secondary deposits along streams that head where Tla outcrops—Ivie Creek, for example. It is from such secondary deposits that the Fremont most likely procured rock for temper. Whereas light-colored basaltic andesite from Tla seems to be the likely source of temper category C, dark-colored basaltic andesite from this same formation could match temper category A.

Tdp is the highly localized intrusive igneous rock of the Henry Mountains laccolith. Though this material occurs in vast scree and fluvial deposits, its natural availability is circumscribed on the west by Hall Creek and Sandy Creek and on the north by the Fremont River. It is not surprising, therefore, that the temper category D was found exclusively in the Henry Mountains sample.

Petrographic Analysis

Petrographic analysis of selected sherds and igneous rocks was conducted to test the tentative correlations between temper categories and geologic units, to describe the mineralogy of the temper categories, and to check for potentially significant variability within each category. Thirty-two thin sections of rock samples from outcrops and secondary deposits were analyzed. The 20 sections of primary sources include five of Tba (sections 7, 8, 10–12), four of Tlo (1–3 and 45), three of Tdp (4–6), three of Qtb (9, 72, and 73), and five of Tla (44, 82, 83, 87 and 88). A majority (n = 7) of the 12 sections of secondary deposits are of cobbles from the gravel-covered ridge of Snake Rock along Ivie Creek; cobbles ultimately derived from the undifferentiated igneous unit mapped as Tla. These sections (78–81 and 84–86) were made to examine variability in the igneous cobbles immediately available at this important Fremont habitation and to gain a better understanding of the Tla unit. One of these seven sections (80) was also made to see if the material matched temper category E. It is one of three rock samples collected from the entire region that appear most similar to the inclusions of category E. The other two possible matches include a cobble from Muddy Creek (71) and one from the Fremont River (75). The other sections from secondary deposits include likely matches of temper category C from the Fremont River (74 and 76) and a likely match of temper category A from the mouth of Salina Creek in the Sevier River valley (77).

[1]One important realization of our field sampling is that Ivie Creek defines the northern limit of igneous rock availability in the San Rafael Swell area. Fremont populations living in all but the very southern portion of Castle Valley would not have had igneous rock immediately available for a tempering agent. So, for example, if Emery Gray was produced at Windy Ridge, the temper would have to have been procured approximately 60 km away.

The analyzed sherds include 26 from south-central Utah (sections 13–43, excluding 16, 19, 20, 30, and 31) and 5 from west-central Utah (50–54). The 26 sherds include the four principal igneous temper categories common to south-central Utah (A through D), an example of the rare temper category E, and several examples of mixed igneous inclusions. This south-central Utah sample consists of 12 sherds from eight sites of the Escalante River basin (21–34, excluding 30 and 31), nine sherds from three sites along Bull Creek (sections 35–43), and five sherds from Snake Rock in the San Rafael Swell area (13–18, excluding 16). Most of the Escalante River basin sample was chosen to cover the range of variability in temper categories A and B, which are common to Fremont pottery of this locality. Also included were two sherds of temper category C, which is common further north in the San Rafael Swell area. The five igneous-tempered sherds from Snake Rock included two of temper category C, the predominant rock temper of this site and the general vicinity; one of temper category A, which is common in the Escalante River basin; one with a mixture of categories A and C; and one with temper category E. The nine igneous-tempered sherds from the Bull Creek sites included two examples of category D, speculated to be local to the Henry Mountains. This category was identified as temper type A during the original ceramic analysis (Lohse 1981:93). The other seven Bull Creek sherds were represented by two of temper category A, two of category C, and three with admixtures of igneous rocks. Five sherds of temper category E from west-central Utah, where this category is common, were included in the analysis for comparative purposes (thin sections for these were generously provided by Lane Richens).

Petrographic analysis was conducted independently of the temper classification. The first step in the analysis was to describe the groundmass and phenocrysts of the geologic samples (Table 1) to provide a known baseline with which to compare the igneous inclusions of prehistoric sherds. Each sherd thin section was compared with rock sample thin sections to identify any positive matches. A summary of the petrographic results is presented in

Table 1. Petrographic description of igneous rock samples of known geologic source and of igneous inclusions in prehistoric sherds not yet positively matched to geologic sources.

Geologic formation	Description
Known source	
Tba	A basaltic andesite with a dark, primarily glassy, but also microcrystalline, groundmass. Contains prominent phenocrysts of feldspar (plagioclase) and green–brown clinopyroxene. The feldspars show simple and polysynthetic twinning and are zoned. Also present are euhedral magnetites. Olivine, showing red staining from alteration, is present, but only as small, rare phenocrysts (rock sections 7, 8, 10–12).
Tlo	A tuff of latitic composition consisting primarily of feldspars in a gray microcrystalline to cryptocrystalline groundmass. Euhedral biotite and anhedral magnetite are other phenocrysts, as are small, rare clinopyroxenes. Feldspars are quite altered, show simple and polysynthetic twinning, and are zoned. The microcrystalline to cryptocrystalline groundmass is essentially feldspar with varying quantities of tiny, dispersed magnetites (rock sections 1–3, 45).
Tdp	A diorite porphyry with a light–colored microcrystalline to crystalline groundmass consisting of feldspar with small quantities of tiny diffuse opaque oxides. Feldspars with simple and polysynthetic twinning, sometimes zoned, are the most common phenocryst, accompanied by lesser amounts of euhedral hornblende. Hornblende is altered by oxidation of iron to varying extent. Clinopyroxenes are present, but small and rare (rock sections 4–6).
Qtb	A basalt with a dark, dense groundmass that is mainly feldspar with augite, olivine, and magnetite. It has abundant olivine phenocrysts with reddened margins but no feldspar phenocrysts. None of the igneous inclusions in any prehistoric sherds look anything like this volcanic (rock sections 9, 72, 73).
Tla	A holocrystalline basaltic andesite with a felty groundmass of plagioclase, clinopyroxene, and dispersed opaque oxides sparsely disseminated throughout. Contains abundant phenocrysts of plagioclase and clinopyroxene. Tiny, highly altered olivines are present but rare. The groundmass ranges from a light gray to black with the dark hues most likely due to finely disseminated opaque minerals and glass (rock sections 44, 82, 83, 87, 88; also sections 78–81, 84–86).
Unknown source	
1	A dark, glassy, finely vesicular, crystal–poor welded tuff containing occasional small feldspar phenocrysts but essentially nothing else. Two samples show rare small clots of clinopyroxenes. The feldspars are commonly untwinned or show simple (Carlsbad) twinning. The vesicules are often stretched (sherd sections 18, 50–54).

Table 2 as a cross-tabulation of sectioned sherds by igneous inclusions of known and unknown geologic source.

The igneous inclusions in many of the sectioned sherds are virtually indistinguishable from rock samples of the igneous units Tba, Tlo, Tla, and

Table 2. Petrographic results of sherd thin sections. The igneous inclusions identified in each sherd are listed by known and unknown geologic source. Also presented are the temper categories identified for each sherd before conducting the petrographic analysis. Several sherds contained more than one igneous inclusion; in such cases, a *capital X* denotes the predominant inclusion. The Tla source is differentiated according to a light groundmass (TlaL) and a dark groundmass (TlaD).

Thin section	Known source					Unknown source		Temper categories				
	Tba	Tlo	Tdp	TlaL	TlaD	1	Other	A	B	C	D	E
14	X							X				
17	X				x			X		x		
21	X	?						X	x			
22	X	?						X	x			
26	X							X				
28	X				x			X		x		
34	X							X				
38	X						x	X				
36	?				X		x	X				
24	?				X			X				
27	?				X			x				
41	?				X			X				
25		X						X				
32		X							X			
33		X							X			
39			X								X	
40			X								X	
43	?		x		X			X		x	x	
13				X						X		
15				X						X		
29				X						X		
35				X						X		
37				X						X		
42				X	x		x	x		X		
18						X						X
50						X	X					X
51						X						X
52						X						X
53						X						X
54						X						X
23							X		X			

Tdp, whereas the igneous unit Qtb has no equivalent in the thin-sectioned sherds.[2] A few of the sherds have igneous inclusions that do not match the rock samples or have a mixture of igneous inclusions, some of which do not match any rock samples. Most of these no-match sherds contained the same type of igneous inclusion—a dark microvesicular glass that was designated as unknown geologic source 1. The petrographic characteristics of this unknown are also described in Table 1; it seems probable that this temper can eventually be matched with a specific geologic outcrop that lies somewhere outside our study area.

If igneous inclusions can be confidently distinguished with a binocular microscope, then this relatively inexpensive method can be used to monitor which specific igneous rocks were used as temper in large samples of pottery. Comparing the results of the two independently derived data sets revealed an overall good degree of correspondence. The lack of agreement between binocular and petrographic results occurs with sherds included in temper category A except for one instance.

Petrographic analysis revealed that the dark igneous inclusions of category A are basaltic andesite that could be derived from either Tba or Tla. One possible means to distinguish between these sources is on the basis of groundmass texture. Some sherds of category A contain a dark glassy groundmass, which, based on our sampling, seems to be restricted to the geologic unit mapped as Tba. Other sherds of category A contain a dark microcrystalline groundmass. This texture variety is available from the Tba unit, but also from the Tla unit as well. Except for this texture difference, there is no apparent mineralogical distinction between these varieties of dark basaltic andesite; moreover, some sherds contain inclusions of both texture varieties. Perhaps more intensive analysis methods such as electron microprobe determination of major and minor elements of temper particles might help to further differentiate pottery with category A inclusions.

Another difference between the results of petrographic and binocular analyses is that petrographic examination at times revealed more igneous inclusions than were identified using the binocular microscope. This happened in three sherds where minor inclusions of some other rock type were detected with the petrographic microscope. To alleviate the possibility of overlooking mixtures of igneous inclusions using the binocular microscope, it is essential to inspect sufficiently large fresh breaks to be sure that the full range of inclusions is seen. It is essential to spend greater time looking for sparsely occurring igneous inclusions that might vary from what at first glance seems to be a single rock type, especially with heavily tempered sherds.

[2]A possible reason for the apparent lack of use of Qtb as a temper agent is that this basalt is exceedingly hard to crush, especially compared with the other igneous rocks available in the region, such as the easily crushed basaltic andesite of Tba.

Summary of Findings

The petrographic analysis confirmed that a variety of igneous rocks were used singly or in various combinations to temper Fremont pottery of Glen Canyon and elsewhere in south-central Utah. At least five petrographically distinctive igneous rocks can be identified in prehistoric sherds using a binocular microscope (temper categories A through E). Comparison of thin sections from sherds and geologic samples showed that four of these five temper categories correspond to igneous formations that outcrop in certain portions of south-central Utah.

The igneous inclusions of temper category A match geologic samples of dark basaltic andesite from two mapped geologic units: Tba, the caprock of Boulder Mountain, and Tla, the caprock for the southeastern portion of the Wasatch Plateau. As a result, pottery of temper category A could have been made across a broad region from the Escalante River basin to the San Rafael Swell area. Temper category A is the dark igneous rock common in Fremont pottery of the Escalante River basin and the Fremont River. This temper type has caused considerable confusion in the past because some archaeologists have classified the pottery with this temper as Sevier Gray and others have classified it as Emery Gray (more will be said about this later).

Temper category B matches Tlo, a latitic tuff that caps the Table Cliffs Plateau and the southern margin of Boulder Mountain. Because Tlo outcrops are spatially restricted within our study area, it is not surprising that temper category B is not very common, being largely confined to the Escalante River basin. Upwards of 10% of the Fremont pottery from this river basin in our sample was tempered with a mixture of tuff and dark basaltic andesite. This is no great surprise because cobbles of both Tlo and Tba occur together on gravel terraces of the Escalante River. Temper category C predominates in the San Rafael Swell area and might be considered the typical temper of Emery Gray. It matches a light-colored basaltic andesite from the undifferentiated igneous unit mapped as Tla. This unit also contains a dark basaltic andesite that appears similar to the Tba of Boulder Mountain except that its groundmass has a microcrystalline rather than glassy texture. Temper category D, which is localized in the central part of the study area, is a positive match with the diorite porphyry of the Henry Mountains laccolith (Tdp). Plain gray pottery of this temper variety could be confused with Mesa Verde plain gray pottery produced from diorite porphyry of the Abajo Mountains.

The distinctive igneous rock of temper category E (unknown source 1) remains to be matched with a source. Temper category E was actually not expected to match any igneous formations from south-central Utah, because it is a common temper of pottery produced west of the Wasatch Plateau and might be considered the typical temper of Sevier Gray. Exceedingly few specimens of this temper category were found in our sample, and these doubtless represent relatively distant trade wares.

Conclusions

The variety of igneous rocks used as temper within the core area of Emery Gray production is unaccounted for in the existing taxonomic structure for classifying Fremont ceramics. Given the number and diversity of igneous rocks further west and northwest of our study area, temper variability in Fremont pottery is doubtless several times greater than what we have observed. This variability is spatially patterned depending on the types of igneous rock available and might be used to infer general zones of ceramic production. Few other Fremont ceramic traits appear to be so spatially patterned in the region.

The existing classificatory scheme with its Emery Gray–Sevier Gray dichotomy is not sensitive to the variety of igneous rock used to temper Fremont pottery. As a direct result, some archaeologists have reached erroneous conclusions about trade, whereas other researchers have lumped together sherds with distinct tempers and different regions of production under a single type. As an example of the former problem, there are the particularly high frequencies of Sevier Gray reported for excavated sites along Bull Creek (Lohse 1981); in several cases, Sevier Gray outnumbered the locally produced Emery Gray. This was interpreted as indicating "ease of contact between the basin and the Colorado Plateau" (Lohse 1981:94). In reanalyzing the Bull Creek collections, we found that virtually all pottery typed as Sevier is tempered with a dark basaltic andesite derived from the igneous units Tba and Tla. Cobbles of both igneous units are abundantly available from terraces of the Fremont River and Muddy Creek several kilometers north of the Bull Creek sites. Therefore, the pottery identified as Sevier is most likely of local manufacture. This is clearly the case for some sherds that contained both the dark basaltic andesite and the locally occurring diorite porphyry (Tdp) from the Henry Mountains laccolith (e.g., sherd sample 43). None of the purported Sevier Gray sherds from Bull Creek that we examined contained the microvesicular black igneous rock of temper category E, a category assuredly exotic to the Bull Creek area and one that could be used to argue for ceramic exchange from the Sevier region.

Lohse cannot be faulted for inferring trade. He observed dark igneous inclusions, which by definition meant Sevier Gray, and because the Bull Creek sites were so distant from the core area of Sevier Gray production as delineated by Madson (1970; see Fig. 2), trade seemed an obvious conclusion. Based on the volume of Sevier Gray at the Bull Creek sites, Lohse could have concluded that Sevier Gray was locally produced. This is precisely what Aikens (1967:16–18) concluded based on the 33% occurrence of Sevier Gray in the Snake Rock ceramic assemblage. The problem with Aikens's inference is that most of the sherds he classified as Sevier Gray have a different temper (basaltic andesite of temper category A and categories A and C mixed) than sherds identified as Sevier Gray from west of the Wasatch Plateau (the black welded tuff of temper category E). Such differences would be obscured by this approach, and potential evidence of long-distance trade would be overlooked (sherds of temper category E at Snake Rock, such as thin section 18).

Continuing to use the existing taxonomic structure for typing igneous-tempered Fremont pottery from south-central Utah can both obscure important spatial information and grossly misinform us. How, though, should we deal with this problem? We should be cognizant of the recent call for "understanding Fremont variation rather than Fremont variants" (Madsen 1989:25). A radical suggestion would be to abandon Emery Gray and Sevier Gray as types and conceive of them as parts of a single igneous-tempered ceramic ware. Variability in temper, paste, and other characteristics could be monitored within this ware using standard analysis techniques to provide the kinds of compositional, technological, functional, and stylistic information of interest.

Alternatively, the defining criteria of Emery Gray and Sevier Gray could be tightened so that only sherds with a particular temper and paste are included in these types. Sevier Gray could be restricted to sherds with the microvesicular black tuff of temper category E within a dark-firing micaceous clay, whereas Emery Gray could be restricted to sherds with the igneous rock of temper category C. This would leave large quantities of sherds uncategorized unless new types were created to account for at least the common tempers. A proliferation of new types is not necessarily what Fremont archaeology needs. Moreover, there is the pottery tempered with more than a single igneous inclusion.

A middle ground would be to recognize at least four temper varieties of Emery Gray. One of these, characterized by temper category C, could be conceived of as the classic Emery Gray because it is the predominant temper of the San Rafael area of Emery County. Another variety characterized by temper category D would have had a very localized production around the Henry Mountains. A third Emery Gray temper variety (temper category A)—one common to the Escalante River basin and doubtless all around the slopes of Boulder Mountain and along the Fremont River—is characterized by dark basaltic andesite inclusions.

Because of the dark igneous inclusions, sherds of this temper variety can be misidentified as Sevier Gray. Though the dark igneous inclusions of this temper variety are distinct from those of Sevier Gray (temper category E), perhaps a more useful distinguishing characteristic is the dark, biotite-laden clay of Sevier Gray. A fourth Emery Gray variety is characterized by temper category B, which in our study area seems to be quite localized in the Escalante River basin.

The problem with recognizing temper varieties of the existing two types is that it does not take into account the limitations of our current knowledge. Because little is known about the igneous rock used to temper Fremont pottery outside our study region, we may eventually learn that the basaltic andesite of temper category A or the latitic tuff of temper category B is common in pottery produced west of the Wasatch Plateau.

Whatever classificatory approach is ultimately adopted by archaeologists working with igneous-tempered Fremont ceramics, it is clear that more basic research is needed on documenting temper and clay sources and on determining the extent to which data patterning is geologically or culturally induced. One promising future avenue will be to combine paste characterization with temper analysis, an approach that may help to define relatively small production zones.

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