CHAPTER 6

PETROGRAPHIC ANALYSIS OF POTTERY FOR THE RIO NUEVO PROJECT, WITH A CASE STUDY OF TEMPORAL TRENDS IN HISTORIC ERA NATIVE AMERICAN POTTERY PRODUCTION

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INTRODUCTION

Petrographic modal analysis, or point counting, is a detailed microscopic analytical technique used to establish the mineralogical composition of a rock or sediment. It has been used extensively to establish composition and provenance of archaeological ceramics, especially in the Greater Southwest. For the Rio Nuevo Archaeology project, 56 sherds from the Clearwater site, AZ BB:13:6 (ASM), and the Tucson Presidio, AZ BB:13:13 (ASM), were selected for petrographic analysis to establish their provenance and to verify the temper characterizations provided by ceramicist James M. Heidke. The sherds are a subset of the 2,373 sherds chosen for detailed ceramic analysis (Chapter 7, this report). They comprise plain and red wares from prehistoric and historic contexts (Table 6.1).

The provenance analysis was conducted using the Tucson Basin petrofacies model. The Tucson Basin and Avra Valley have been a focus of petrographic sand temper studies for over 20 years. More than 500 sand samples have been collected and point counted, and statistical models have been developed to define petrofacies, or distinct sand composition zones, within the basin (Figure 6.1) (Lombard 1987; Miksa 2003, 2006). Many of these petrofacies are very limited in geographic extent, so that compositional changes are detailed on scales of kilometers to tens of kilometers. Excavation and subsurface sampling have shown that the sand composition at the surface has remained essentially unchanged for the last several thousand years. Therefore, the petrofacies model provides a way to compare the sand temper in sherds to the actual locations from which sand of various compositions could be procured. Ethnographic data from around the world indicate that potters who use sand for temper tend to procure it within 3 km—most often from within 1 km—of their pottery production location (Arnold 1985; Heidke 2006). These data are based on people who use only human labor to carry their materials—boats, beasts of burden, or vehicles of any sort are not included. Thus, we feel comfortable in asserting that the provenance of the sand temper in pottery indicates the provenance of the pottery itself.

METHODS

Temper characterization was conducted under a Unitron ZSM stereozoom microscope with magnifications of 6x to 30x. A three-part temper identification code was used: (1) temper type (TT) records what type of material was used (sand, grog, and so forth); (2) generic temper source (TSG) records the general temper composition and the likely group of petrofacies to which the temper belongs; and (3) specific temper source (TSS) records the specific petrofacies to which the ceramicist thinks the temper should be assigned.

Unfortunately, the temper characterization for Rio Nuevo was conducted prior to completion of the formal Tucson Basin petrofacies model. Consequently, while Heidke knew the major petrofacies in the Tucson Basin from extensive previous experience, less well-characterized, rarely encountered petrofacies were not fully included in his analysis. The full statistical model and descriptions are available as of this writing, and the petrographic verification was conducted with the completed mode. However, any errors or omissions must be evaluated in the light of the incomplete information available to Heidke at the time of temper characterization.

The most notable additions to the model are better characterization of the granitic and mixed lithic petrofacies. These include the basin fill and the bajada petrofacies that have volcanic input. In particu-

Table 6.1. Inventory of sherd samples from the Rio Nuevo Archaeology project submitted for petrographic analysis.

Sample Number	AZ (ASM) Site Number	Feature Number	Field Number	Obs	Ceramic Type
RNA2-01	BB:13:6	166	6692	154	Indeterminate red
RNA2-02	BB:13:6	166	6703	13	Indeterminate red
RNA2-03	BB:13:6	203	6600	18	Indeterminate red
RNA2-04	BB:13:6	64	6249	121	Unspecified plain ware
RNA2-05	BB:13:6	166	6692	25	Indeterminate red
RNA2-06	BB:13:6	166	6692	46	Indeterminate red
RNA2-07	BB:13:6	166	6703	38	Unspecified plain ware
RNA2-08	BB:13:6	178	6500	8	Indeterminate red
RNA2-09	BB:13:6	178	6500	9	Indeterminate red
RNA2-10	BB:13:6	178	6500	16	Indeterminate red
RNA2-11	BB:13:6	203	6600	8	Indeterminate red
RNA2-12	BB:13:6	203	6600	20	Indeterminate red
RNA2-13	BB:13:6	161	6531	2	Indeterminate red
RNA2-14	BB:13:6	166	6692	41	Indeterminate red
RNA2-15	BB:13:6	203	6600	19	Indeterminate red
RNA2-16	BB:13:6	203	6601	2	Indeterminate red
RNA2-17	BB:13:6	64	6249	91	Sobaipuri Plain (folded rim)
RNA2-18	BB:13:6	64	6249	100	Unspecified plain ware
RNA2-19	BB:13:6	178	6500	32	Unspecified plain ware
RNA2-20	BB:13:6	203	6601	1	Unspecified plain ware
RNA2-21	BB:13:6	4	5127	4	Papago Plain
RNA2-22	BB:13:6	61	5981	1	Papago Red
RNA2-23	BB:13:6	61	6224	2	Papago Red
RNA2-24	BB:13:6	1	5435	1	Indeterminate red
RNA-39	BB:13:13	373	2460	2	Sobaipuri Plain (folded rim)
RNA-40	BB:13:13	409	4260	2	Unspecified plain ware
RNA-41	BB:13:13	373	2460	12	Sobaipuri Plain (folded rim)
RNA-42	BB:13:6	3014	8168	2	Unspecified plain ware
RNA-43	BB:13:6	3038	8188	1	Unspecified plain ware
RNA-44	BB:13:13	441	4286	2	Papago Red
RNA-45	BB:13:13	422	4049	1	Papago Plain
RNA-46	BB:13:13	373	2372	1	Unspecified plain ware
RNA-47	BB:13:13	409	4260	7	Indeterminate red
RNA-48	BB:13:13	441	4269	3	Unspecified plain ware
RNA-49	BB:13:13	373	2456	2	Sobaipuri Plain (folded rim)
RNA-50	BB:13:13	409	4192	2	Unspecified plain ware
RNA-51	BB:13:13	441	4286	1	Sobaipuri Plain (folded rim)
RNA-52	BB:13:13	373	2372	10	Sobaipuri Plain (folded rim)
RNA-53	BB:13:13	376	2606	10	Unspecified plain ware
RNA-54	BB:13:13	373	2456	4	Indeterminate red
RNA-55	BB:13:13	409	4192	3	Sobaipuri Plain (folded rim)
RNA-56	BB:13:13	441	4269	1	Unspecified plain ware
RNA-57	BB:13:13	409	4153	12	Indeterminate red

Table 6.1. Continued.

Sample Number	AZ (ASM) Site Number	Feature Number	Field Number	Obs	Ceramic Type
RNA-58	BB:13:13	376	3722	2	Papago Plain
RNA-59	BB:13:13	376	3748	4	Papago Red
RNA-60	BB:13:13	409	4153	14	Papago Red
RNA-61	BB:13:13	409	4160	1	Papago Plain
RNA-62	BB:13:13	376	2577	2	Papago Plain
RNA-63	BB:13:13	376	2577	19	Papago Red
RNA-64	BB:13:13	376	2606	2	Papago Plain
RNA-65	BB:13:13	376	2606	24	Papago Red
RNA-66	BB:13:13	376	2644	1	Papago Plain
RNA-67	BB:13:13	376	2644	2	Papago Plain
RNA-68	BB:13:13	376	2644	24	Papago Red
RNA-69	BB:13:13	376	2646	2	Papago Plain
RNA-70	BB:13:13	376	3768	1	Papago Plain

lar, the petrofacies model of the floor of the Tucson Basin proper—bounded by the Santa Cruz River on the west, the Rillito River on the north, the Pantano Wash on the east, and approximately the town of Sahuarita on the south—has undergone major changes. The floor of the Tucson Basin is an agglomeration of alluvial sediments that have accumulated over thousands of years. Gradational composition changes occur from south to north and from east to west. Determining where to draw petrofacies boundaries in this very gradational sedimentary environment has been challenging.

In 2003 and 2004, additional samples were collected from the southern end of the basin, near Sahuarita, and at the southeastern corner, near Pantano Wash and Cienega Creek. Additionally, samples from the Rincon Petrofacies were reanalyzed. In some cases, new thin sections were made, because the original thin sections were uncovered and unstained, hampering detailed mineralogical analysis. Finally, we tested our ability to distinguish sands from provisionally assigned petrofacies on the basin floor from one another in hand-sample. With this new information available, we concluded that we could not reliably distinguish the provisional petrofacies in hand-sample. The gradational compositions of the basin floor make boundary definitions difficult.

The new samples, the reanalysis, and the hand-sample testing led to several changes. The new petrofacies map is provided in Figure 6.1. The most notable changes are among the petrofacies on the floor of the Tucson Basin and in the Black Mountain area. The Black Mountain Petrofacies was previously characterized based on only three samples. Collection of additional samples has significantly improved the definition of the Black Mountain Petrofacies. This improved definition was not available to Heidke when he characterized temper in Rio Nuevo project sherds, so he could not easily identify this area as a potential source. A full description of the changes is provided in Miksa (2006).

Petrographic Analysis

The 56 sherds selected for petrographic analysis were sent to Quality Thin Sections of Tucson, Arizona, for standard thin-section preparation, including staining for calcium and potassium to allow feldspars to be easily recognized. Detailed petrographic analysis was done for each thin section using the methods outlined in Miksa and Heidke (2001). The Gazzi-Dickinson method was used to point count all samples for provenance analysis (Dickinson 1970; Miksa and Heidke 2001). This method treats each sand-sized grain as an individual mineral. It provides detailed mineralogical composition of the sample, and allows for comparisons of sands and sand tempers that may be more mature or less mature—that is, more or less broken down into their constituent grains. A standard set of point-count parameters, developed for the Tucson Basin, was used for the analysis (Table 6.2) (Miksa 2003, 2006). The point-count data collected for each sherd are provided in Table 6.3, while the qualitative petrographic data collected for each sherd are provided in Table 6.4.

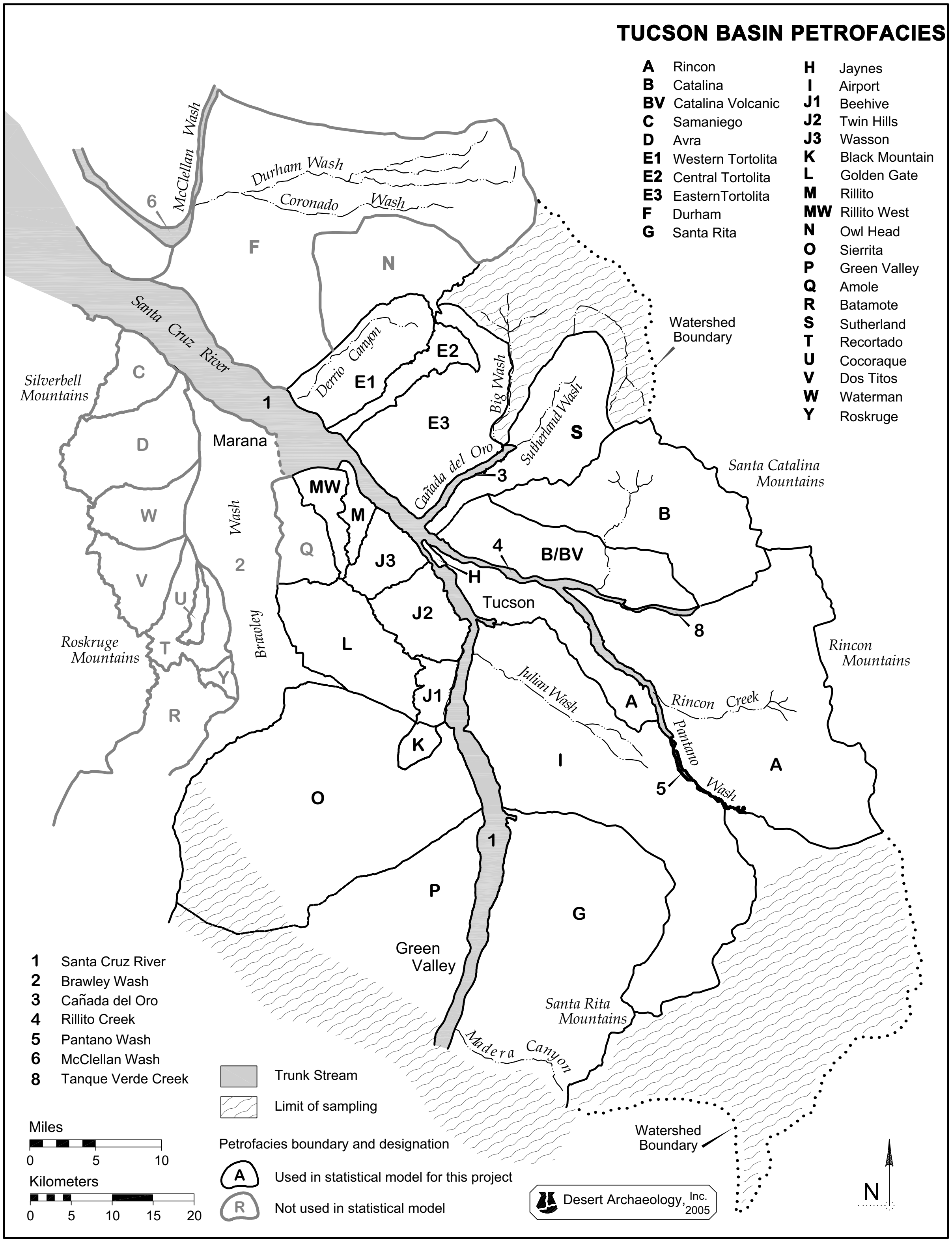

Figure 6.1. Current petrofacies map of the Tucson Basin.

Table 6.2. Point-count parameters and calculated parameters used for the petrographic analysis of Tucson Basin sands and sherds.

Parameter	Description
Totals and Calculated Parameters	
Total temper	The total number of point-counted sand-sized grains, including crushed rock, clay lumps, fiber temper, or grog.
Voids	The total number of open voids encountered in the paste.
Paste	The total number of points counted in the silt- to clay-sized fraction of the paste.
Paste percent	The proportion of points in the silt- to clay-sized fraction of the paste (Paste/[Paste + Total Temper]) x 100.
Grog	Sherd temper: dark, semiopaque angular-to-subround grains, with discrete margins, including silt- to sand-sized temper grains in a clay matrix, with or without iron oxides and/or micas. The grains differ in color and/or texture from the surrounding matrix of the "host" ceramic. This parameter is counted only in sherd samples.
Clay lump	Discrete "lumps," or grains, of untempered clay. These are generally in the sand-sized range. They comprise clay that lacks silt- to sand-sized grains. These grains are often similar in color to the surrounding paste, but they have well-defined, abrupt boundaries. Their internal texture is finer than the paste and has a different orientation. They are assumed to be clay that was insufficiently mixed with the surrounding clay body.
Sand total	The total number of point-counted *sand* grains; i.e., total temper *minus* clay lumps and grog.
Monomineralic Grains	
Qtz	All sand-sized quartz grains, except those derived from, or contained within, coarse-foliated rocks; unstained.
Kspar	Alkali feldspars, except those derived from, or contained within, coarse-foliated rocks; potassium feldspar stained yellow, unstained plagioclase feldspar, perthite, antiperthite.
Micr	Microcline/Anorthoclase: alkali feldspar, with polysynthetic (cross-hatch) twinning; stained yellow or unstained.
Sanid	Sanidine; volcanic alkali feldspar.
Plag	Plagioclase feldspar, stained pink, except grains derived from, or contained within, coarse-foliated rocks. Grains commonly have albite twinning and/or carlsbad twinning. Alteration, sericitization affect less than 10 percent of the grain.
Plagal	Altered plagioclase, except grains derived from, or contained within, coarse-foliated rocks. Alteration affects 10 percent to 90 percent of the grain; alteration products include sericite, clay minerals, carbonate, epidote.
Plaggn	Considerably altered plagioclase, except grains derived from, or contained within, coarse-foliated rocks; alteration affects more than 90 percent of the grain.
Musc	Muscovite mica.
Biot	Biotite mica.
Chlor	Chlorite group minerals.
Px	Undifferentiated members of the pyroxene group.
Amph	Undifferentiated members of the amphibole group.
Oliv	Olivine.
Opaq	Undifferentiated opaque minerals, such as magnetite/ilmenite, rutile, and iron oxides.
Epid	Undifferentiated members of the epidote family (epidote, zoisite, clinozoisite).
Sphene	Sphene.
Gar	Undifferentiated members of the garnet group.

Table 6.2. Continued.

Parameter	Description
Monomineralic Grains in Coarse-foliated Rocks	
Sqtz	All quartz derived from, or contained within, coarse-foliated rocks.
Skspar	Potassium feldspar derived from, or contained within, coarse-foliated rocks.
Splag	Plagioclase feldspar derived from, or contained within, coarse-foliated rocks.
Smusc	Muscovite mica derived from, or contained within, coarse-foliated rocks.
Sbiot	Biotite mica derived from, or contained within, coarse-foliated rocks.
Schlor	Undifferentiated chlorite group minerals derived from, or contained within, coarse-foliated rocks.
Sopaq	Undifferentiated opaque minerals derived from, or contained within, coarse-foliated rocks.
Metamorphic Lithic Fragments	
Lmvf	Metamorphosed volcanic rock such as rhyolite. Massive-to-foliated aggregates of quartz and feldspar grains with relict phenocrysts of feldspar.
Lmss	Metamorphosed sedimentary rock, such as a meta-siltstone. Massive fine-grained aggregates of quartz and feldspar, with or without relict sedimentary texture.
Lmamph	Amphibolite: a high-grade metamorphic rock, composed largely of amphibole.
Lma	Quartz-feldspar (mica) aggregate: quartz, feldspars, mica, and opaque oxides in aggregates with highly sutured grain boundaries but no planar-oriented fabric; some are schists or gneisses viewed on edge; some are metasediments or metavolcanics.
Lmt	Quartz-feldspar-mica tectonite (schists or gneisses): quartz, feldspars, micas, and opaque oxides, with strong planar oriented fabric; often display mineral segregation with alternating quartz-felsic and mica ribbons. Grains are often extremely sutured and/or elongated.
Lmtp	Phyllite: like Lmt, but the grains are silt-sized or smaller, with little or no mineral segregation. Also argillaceous grains, which exhibit growth of planar-oriented micas, silt-sized or smaller.
Lmm	Microgranular quartz aggregate: non-oriented polygonal aggregates of newly grown, strain-free quartz crystallites, with sutured, planar, or curved grain boundaries.
Lmf	Foliated quartz aggregate: planar-oriented fabric developed in mostly strained quartz crystals with sutured crystallite boundaries; quartzite.
Volcanic Lithic Fragments	
Lvf	Felsic volcanic such as rhyolite: microgranular nonfelted mosaics of submicroscopic quartz and feldspars, often with microphenocrysts of feldspar, quartz, or rarely, ferromagnesian minerals. Groundmass is fine to glassy, always has well-developed potassium feldspar (yellow) stain, may also have plagioclase (pink) stain.
Lvfb	Biotite-bearing felsic volcanic: microgranular nonfelted mosaics of submicroscopic quartz and feldspars, often with microphenocrysts of feldspar, quartz, always with phenocrysts of biotite. Groundmass is fine to glassy, always has well-developed potassium feldspar (yellow) stain.
Lvi	Intermediate volcanic rock such as rhyodacite, dacite, latite, and andesite.
Lvm	Basic volcanic: visible microlites or laths of feldspar crystals in random-to-parallel fabric, usually with glassy or devitrified or otherwise altered dark groundmass; often with phenocrysts of opaque oxides, occasional quartz, olivine, or pyroxene. Rarely yellow stained, often very well-developed pink stain, representing intermediate-to-basic lavas, such as latite, andesite, quartz-andesite, basalt, or trachyte.
Lvv	Glassy volcanics: vitrophyric grains, showing relict shards, pumiceous fabric, welding, or perlitic structures; sometimes with microphenocrysts, representing pyroclastic or glassy volcanic rocks.
Lvh	Hypabyssal volcanics (shallow igneous intrusive rocks): equigranular anhedral-to-subhedral feldspar-rich rocks, with no glassy or devitrified groundmass, coarser-grained than Lvf, most have yellow and pink stain.

Table 6.2. Continued.

Parameter	Description
Sedimentary Lithic Fragments	
Lss	Siltstones: granular aggregates of equant subangular-to-rounded silt-sized grains, with or without interstitial cement. May be well-to-poorly sorted, with or without sand-sized grains. Composition varies from quartzose to lithic-arkosic, with some mafic-rich varieties.
Lsa	Argillaceous: dark, semiopaque, extremely fine grained without visible foliation, may have mass extinction, variable amounts of silt-sized inclusions, representing shales, slates, and mudstones.
Lsch	Chert: microcrystalline aggregates of pure silica.
Lsca	Carbonate: mosaics of very fine calcite crystals, with or without interstitial clay- to sand-sized grains. Most appear to be fragments of soil carbonate (caliche) and are subround to very round.
Caco	Sand-sized calcium carbonate minerals. Technically, these should be listed with the monocrystalline grains, but they most often co-occur with caliche or other sedimentary rocks.
Unknown and Indeterminate Grains	
Unkn	Grains that cannot be identified, grains that are indeterminate, and grains such as zircon and tourmaline that occur in extremely low percentages.
Calculated Parameters Used in the Statistical Analyses	
TQtz	Qtz + Sqtz
TKspar	Kspar + Skspar
K	Kspar + Skspar + Micr + Sanid
TPlag	Plag + Plagal + Plaggn + Splag
F	Kspar + Skspar + Micr + Sanid + Plag + Plagal + Plaggn + Splag
TMusc	Musc + Smusc
TBiotchlor	Biot + Sbiot + Chlor + Schlor
Mica	Musc + Smusc + Biot + Sbiot + Chlor + Schlor
Pyr	Px + Amph
Plagpyr	Tplag + Pyr
TOpaq	Opaq + Sopaq
Pyrepid	Pyr + Epid
PyrOpaq	Pyr + Topaq
Hmin	Pyr + Topaq + Tbiotchlor
Lma2	Lma + Lmamph + Lmss + Lmvf + Lmepid
Lmatp	Lma2 + Lmt + Lmtp
Lmmftp	Lmm + Lmf + Lmt + Lmtp
Lmmf	Lmm + Lmf
Lm	Lmm + Lmf + Lma + Lmamph + Lmss + Lmvf + Lmepid + Lmt + Lmtp
Lm_Musc	Lm + Tmusc
Lvf2	Lvfb + Lvf
Lvm2	Lvi + Lvm
Lvmf2	Lvfb + Lvf + Lvi + Lvm
Lv	Lvfb + Lvf + Lvi + Lvm + Lvh + Lvv
Ls	Lss + Lsa + Lsch + Lsca + Caco
Lsclas	Lss + Lsa + Lsch
Lscaco	Lsca + Caco

Table 6.3. Point-count data for the thin-sectioned sherds.

A. Inventory, total points counted and paste characterization

Sample No.	Sample Type	Petro-facies	Obs[a]	Petrologists' Temper Type	Total Grains Counted	Paste	Voids	Fiber Voids	Grog	Clay Lumps
RNA2-01	Sherd	H2	1	Sandy clay (may have crushing features)	152	806	43	2	1	7
RNA2-02	Sherd	J1	1	Sand	268	551	65	1	5	1
RNA2-03	Sherd	J1	2	Sand and crushed rock, where crushed rock >25%	152	0	0	0	0	1
RNA2-04	Sherd	J1	1	Sand	288	347	21	3	1	0
RNA2-05	Sherd	K	1	Sand	248	582	105	3	6	0
RNA2-06	Sherd	J1	1	Sand	269	603	50	0	2	1
RNA2-07	Sherd	J1	1	Sand	309	611	55	1	7	1
RNA2-08	Sherd	J1	1	Sand	312	450	64	0	4	1
RNA2-09	Sherd	J1	1	Sand	263	395	27	2	7	1
RNA2-10	Sherd	K	1	Sand	299	392	35	1	1	2
RNA2-11	Sherd	J1	1	Sand	201	612	116	2	1	0
RNA2-12	Sherd	J1	1	Sandy clay (may have crushing features)	202	481	40	3	3	1
RNA2-13	Sherd	J1	1	Sand plus grog	240	479	48	0	21	7
RNA2-14	Sherd	J1	1	Sand plus grog	207	446	13	0	26	1
RNA2-15	Sherd	J1	1	Sandy clay plus grog	298	624	14	0	55	8
RNA2-16	Sherd	J1	1	Sand plus grog	252	500	93	0	29	1
RNA2-17	Sherd	J1	1	Sand plus grog	212	430	74	0	28	1
RNA2-18	Sherd	J1	1	Sand plus fiber temper	217	312	238	0	5	0
RNA2-19	Sherd	J1	1	Sand plus fiber temper	265	336	85	2	2	1
RNA2-20	Sherd	J1	1	Sandy clay plus grog	321	482	28	1	57	7
RNA2-21	Sherd	?G	1	Sand plus fiber temper	242	482	27	18	2	0
RNA2-22	Sherd	K	1	Sand plus fiber temper	276	349	42	31	3	3
RNA2-23	Sherd	J2	1	Sand plus fiber temper	277	405	40	46	4	2
RNA2-24	Sherd	J1	1	Sand	251	391	219	1	3	2
RNA-39	Sherd	K	1	Sand	264	477	141	2	0	0
RNA-40	Sherd	J1	1	Sand	263	538	138	3	1	0
RNA-41	Sherd	K	1	Sand	254	300	152	3	2	0
RNA-42	Sherd	J2	1	Sand	281	287	117	0	2	0
RNA-43	Sherd	J2	2	Sand plus grog	302	598	42	0	9	0

Table 6.3. A. Continued.

Sample No.	Sample Type	Petro-facies	Obs[a]	Petrologists' Temper Type	Total Grains Counted	Paste	Voids	Fiber Voids	Grog	Clay Lumps
RNA-44	Sherd	K	1	Sand plus fiber temper	329	550	120	85	0	0
RNA-45	Sherd	K	1	Sand	201	510	35	28	0	1
RNA-46	Sherd	K	1	Sandy clay (may have crushing features)	290	453	55	7	0	0
RNA-47	Sherd	K	1	Sand	283	478	58	3	2	1
RNA-48	Sherd	K	1	Sandy clay (may have crushing features)	261	513	87	4	2	0
RNA-49	Sherd	O	1	Sandy clay (may have crushing features)	234	540	246	0	1	0
RNA-50	Sherd	G	1	Sandy clay (may have crushing features)	281	465	170	6	0	0
RNA-51	Sherd	K	1	Sand + grog + 1-7% crushed rock	252	560	142	0	52	0
RNA-52	Sherd	J1	1	Sandy clay plus grog	248	345	98	0	101	0
RNA-53	Sherd	J1	1	Sand + grog + 1-7% crushed rock	274	484	202	0	51	0
RNA-54	Sherd	J1	1	Sandy clay plus grog	272	526	101	0	74	0
RNA-55	Sherd	J1	1	Sand + grog + 1-7% crushed rock	300	449	146	0	33	0
RNA-56	Sherd	J1	1	Sand plus grog	307	537	113	0	51	0
RNA-57	Sherd	K	1	Sand plus grog	323	511	161	0	44	0
RNA-58	Sherd	O	1	Sand plus fiber temper	311	596	86	84	0	12
RNA-59	Sherd	O	1	Sand plus fiber temper	319	514	165	78	0	0
RNA-60	Sherd	O	2	Sand plus fiber temper	229	696	119	13	0	3
RNA-61	Sherd	O	1	Sand plus fiber temper	321	605	58	91	0	0
RNA-62	Sherd	O	1	Sand plus fiber temper	367	448	91	70	0	2
RNA-63	Sherd	O	1	Sand plus fiber temper	379	435	87	114	0	2
RNA-64	Sherd	O	1	Sand plus fiber temper	368	618	38	151	0	10
RNA-65	Sherd	O	1	Sand plus fiber temper	397	586	63	181	0	1
RNA-66	Sherd	O	1	Sand plus fiber temper	302	495	122	90	1	1
RNA-67	Sherd	O	1	Sand plus fiber temper	293	460	147	75	1	1
RNA-68	Sherd	O	1	Sand plus fiber temper	293	460	230	73	0	1
RNA-69	Sherd	O	1	Sand plus fiber temper	289	495	185	64	1	2
RNA-70	Sherd	O	1	Sand plus fiber temper	309	436	235	50	0	6
RNA-3575	Ethnographic clay	O	1	Sand plus fiber temper	346	470	135	118	0	0
RNA-3642	Ethnographic clay	O	1	Not tempered	293	530	78	19	0	0
RNA-6100	Ethnographic clay	O	1	Sand plus fiber temper	335	520	90	93	0	1

[a]The "obs" number is used to distinguish among different point counts of the same thin section. Only one point count per thin section is used for statistical purposes.

Table 6.3. Point-count data for the thin-sectioned sherds.

B. Monocrystalline grains and unknown grains

	Monocrystalline Grains																			
Sample No.	Qtz	Kspar	Micr	Sanid	P	Plag	Plagal	Plaggn	Musc	Biot	Chlor	Pyr	Px	Amph	Opaq	Oliv	Epid	Sphene	Gar	Unkn
RNA2-01	48	10	4	0	37	7	14	1	1	8	2	4	0	4	9	0	0	0	0	0
RNA2-02	45	2	7	0	53	21	24	0	12	1	18	5	0	5	3	0	3	0	0	0
RNA2-03	48	7	7	0	42	21	21	0	0	1	3	2	0	2	4	0	3	0	0	1
RNA2-04	32	10	1	0	51	18	31	1	0	10	11	0	0	0	8	0	0	0	0	0
RNA2-05	81	19	17	0	57	22	20	0	2	4	2	4	0	4	6	0	2	0	0	0
RNA2-06	100	14	7	0	76	31	28	1	1	5	6	1	0	1	4	0	2	0	0	0
RNA2-07	96	6	11	0	105	60	37	1	2	5	4	3	0	3	1	0	3	1	0	0
RNA2-08	78	23	23	0	81	45	35	0	1	9	7	7	0	7	7	0	2	0	1	0
RNA2-09	59	11	14	0	90	43	45	0	0	3	4	4	0	4	6	0	0	0	0	0
RNA2-10	78	4	8	0	107	57	48	1	1	1	3	4	0	4	8	0	3	0	0	0
RNA2-11	54	21	6	0	54	34	16	1	0	6	7	0	0	0	1	0	1	1	0	0
RNA2-12	69	10	6	0	48	14	31	0	0	3	9	1	0	1	5	0	1	0	0	0
RNA2-13	45	1	0	0	48	15	31	1	6	2	3	3	1	2	19	0	0	1	0	1
RNA2-14	50	4	1	0	25	8	16	1	1	0	2	0	0	0	9	0	0	0	0	0
RNA2-15	66	2	0	0	45	12	33	0	2	3	4	0	0	0	13	0	1	0	0	1
RNA2-16	61	1	0	0	51	11	38	2	7	2	7	0	0	0	12	0	0	0	0	0
RNA2-17	43	2	2	0	40	28	10	2	0	4	3	0	0	0	5	0	0	0	0	0
RNA2-18	63	0	0	0	28	14	10	2	0	3	4	1	0	1	13	0	0	0	0	1
RNA2-19	49	6	1	0	71	28	31	2	1	2	1	0	0	0	17	0	0	0	0	0
RNA2-20	51	1	0	0	48	11	33	3	3	2	7	0	0	0	22	0	0	0	0	0
RNA2-21	64	3	3	0	69	33	33	0	0	5	7	5	2	3	5	0	1	2	0	0
RNA2-22	53	2	48	0	98	53	41	0	1	0	1	2	1	1	5	0	0	0	0	0
RNA2-23	47	13	5	0	54	14	37	1	0	1	1	2	1	1	5	0	0	0	0	0
RNA2-24	82	14	14	0	69	12	41	1	1	1	2	1	0	1	2	0	2	0	0	0
RNA-39	70	29	7	0	106	70	35	1	1	2	4	5	0	5	15	0	3	1	0	0
RNA-40	58	21	16	0	93	68	25	0	1	3	7	2	0	2	8	0	0	0	0	0
RNA-41	60	20	21	0	104	82	22	0	0	0	4	0	0	0	4	0	0	0	0	0
RNA-42	75	17	1	0	90	38	51	1	1	1	3	0	0	0	13	0	0	0	0	0
RNA-43	29	3	2	0	62	38	23	1	4	0	3	0	0	0	10	0	0	0	0	0

Table 6.3. B. Continued.

	Monocrystalline Grains																			
Sample No.	Qtz	Kspar	Micr	Sanid	P	Plag	Plagal	Plaggn	Musc	Biot	Chlor	Pyr	Px	Amph	Opaq	Oliv	Epid	Sphene	Gar	Unkn
RNA-44	72	1	15	0	101	50	48	3	1	1	2	3	0	3	10	0	2	0	0	0
RNA-45	48	13	15	0	56	32	23	1	0	3	2	4	0	4	4	0	0	0	0	0
RNA-46	86	1	15	0	105	78	27	0	0	2	6	8	0	8	7	0	2	0	0	0
RNA-47	90	23	12	0	94	43	50	1	0	3	3	8	0	8	14	0	1	0	0	0
RNA-48	49	3	13	0	123	107	16	0	0	1	2	8	0	8	16	0	1	0	0	1
RNA-49	68	7	9	0	87	48	38	1	1	1	0	2	0	2	6	0	1	0	0	0
RNA-50	85	20	8	0	101	67	34	0	0	6	5	2	0	2	2	0	3	2	0	1
RNA-51	36	3	7	0	100	92	8	0	0	0	1	0	0	0	15	0	2	0	0	0
RNA-52	24	7	8	0	36	29	7	0	2	0	1	1	1	0	13	0	1	0	0	1
RNA-53	39	11	0	5	23	11	10	0	2	2	0	0	0	0	3	0	0	0	0	2
RNA-54	40	8	2	1	23	17	5	1	2	0	3	0	0	0	17	0	3	0	0	0
RNA-55	34	16	0	1	84	65	17	2	4	0	6	0	0	0	8	0	0	0	0	1
RNA-56	35	6	8	12	67	44	22	1	0	0	6	1	1	0	21	0	0	0	0	0
RNA-57	56	15	12	3	102	84	18	0	0	0	9	1	0	1	8	0	0	0	0	0
RNA-58	53	3	39	0	66	53	13	0	0	0	2	1	0	1	7	0	0	0	0	2
RNA-59	63	10	38	0	114	93	21	0	0	1	1	0	0	0	6	0	0	1	0	2
RNA-60	54	14	11	0	73	51	22	0	0	0	6	5	2	3	3	0	1	0	0	0
RNA-61	71	17	45	0	87	70	17	0	0	0	0	0	0	0	2	0	0	0	0	2
RNA-62	64	58	28	0	114	104	10	0	0	0	1	6	6	0	14	0	2	0	0	1
RNA-63	54	29	27	0	106	93	13	0	1	0	0	3	2	1	26	0	0	3	0	1
RNA-64	61	10	35	0	83	61	22	0	0	0	0	0	0	0	11	0	0	0	0	2
RNA-65	64	5	36	0	93	77	16	0	0	0	1	1	0	1	4	0	0	0	0	3
RNA-66	63	2	45	0	76	45	30	1	1	0	1	3	2	1	7	0	0	0	0	0
RNA-67	52	5	51	0	82	57	25	0	1	0	1	0	0	0	9	0	0	1	0	0
RNA-68	52	3	48	0	99	84	15	0	0	0	1	1	1	0	10	0	0	0	0	0
RNA-69	58	2	41	0	99	75	23	1	0	1	1	1	0	1	9	0	0	0	0	0
RNA-70	64	8	51	0	109	73	36	0	2	1	1	1	1	0	6	0	0	1	0	0
RNA-3575	71	1	4	0	129	114	15	0	0	0	0	4	0	4	14	0	3	2	0	0
RNA-3642	85	5	47	0	121	43	78	0	0	0	1	1	0	1	12	0	0	0	0	0
RNA-6100	76	2	28	0	99	88	11	0	0	2	2	4	1	3	7	0	2	0	0	0

Table 6.3. Point-count data for the thin-sectioned sherds.

C. Metamorphic lithic fragments and monocrystalline grains from gneiss or schist

	Metamorphic Lithic Fragments								Monocrystalline Grains from Gneiss or Schist						
Sample No.	Lma	Lmvf	Lmss	Lmamph	Lmt	Lmtp	Lmm	Lmf	Sqtz	Splag	Skspar	Smusc	Sbiot	Schlor	Sopaq
RNA2-01	0	4	0	0	2	0	0	1	35	15	7	1	0	0	0
RNA2-02	0	3	0	0	4	0	1	0	39	8	0	0	1	0	0
RNA2-03	0	1	0	0	3	0	0	0	0	0	0	0	0	0	0
RNA2-04	0	7	0	0	7	0	0	0	8	1	2	0	0	0	0
RNA2-05	0	1	1	0	2	0	0	0	50	15	4	0	0	0	1
RNA2-06	0	6	0	0	6	0	1	0	68	16	1	0	1	0	0
RNA2-07	1	4	0	0	13	0	0	0	44	7	0	0	0	0	0
RNA2-08	1	6	0	0	6	0	1	0	32	1	0	0	1	2	0
RNA2-09	1	2	0	0	6	0	0	0	21	2	0	0	0	0	0
RNA2-10	0	7	0	0	5	0	0	0	20	1	0	0	0	0	0
RNA2-11	1	1	1	0	7	0	1	0	14	3	0	0	1	0	0
RNA2-12	1	1	0	0	3	0	0	0	30	3	0	0	0	0	0
RNA2-13	2	7	1	0	4	0	0	0	2	1	0	0	0	0	1
RNA2-14	1	3	0	0	5	0	0	0	3	0	0	0	0	0	0
RNA2-15	1	6	0	0	11	0	0	0	3	0	0	0	1	0	0
RNA2-16	0	11	1	0	16	1	0	0	4	0	0	0	0	2	0
RNA2-17	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
RNA2-18	0	5	0	0	8	0	0	0	9	2	0	0	0	0	0
RNA2-19	1	7	1	0	5	0	1	0	7	10	0	0	0	0	0
RNA2-20	0	16	1	0	12	0	0	0	6	1	0	0	0	0	0
RNA2-21	0	1	0	0	2	0	0	0	9	3	0	0	0	0	0
RNA2-22	0	0	0	0	0	0	0	0	11	4	0	0	0	0	0
RNA2-23	0	2	0	0	5	0	0	0	7	2	0	0	0	0	0
RNA2-24	1	6	0	0	2	0	0	1	53	15	1	0	0	0	0
RNA-39	1	0	0	0	3	0	0	0	0	0	0	0	0	1	0
RNA-40	0	3	1	0	2	0	0	0	1	0	0	0	0	0	0
RNA-41	1	3	0	0	10	0	0	0	0	0	0	0	0	0	0
RNA-42	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0
RNA-43	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 6.3. C. Continued.

	Metamorphic Lithic Fragments								Monocrystalline Grains from Gneiss or Schist						
Sample No.	Lma	Lmvf	Lmss	Lmamph	Lmt	Lmtp	Lmm	Lmf	Sqtz	Splag	Skspar	Smusc	Sbiot	Schlor	Sopaq
RNA-44	0	1	0	0	2	0	0	2	0	0	0	1	0	0	0
RNA-45	1	0	0	0	3	0	0	1	0	0	0	0	0	0	0
RNA-46	0	5	0	0	5	0	0	0	0	0	0	0	0	0	0
RNA-47	0	1	0	0	2	1	0	0	0	0	0	0	0	0	0
RNA-48	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0
RNA-49	0	7	0	0	4	0	0	0	0	0	0	0	0	0	0
RNA-50	0	4	0	0	7	0	0	0	0	0	0	0	1	1	0
RNA-51	4	0	0	0	3	0	0	0	0	0	0	0	0	0	0
RNA-52	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0
RNA-53	1	0	0	0	4	0	0	0	1	2	0	1	0	0	0
RNA-54	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
RNA-55	0	0	0	0	2	0	0	0	3	0	0	1	0	0	1
RNA-56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RNA-57	0	0	0	0	0	0	0	0	4	0	1	0	0	0	0
RNA-58	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RNA-59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RNA-60	0	1	0	0	5	0	0	1	0	0	0	0	0	0	0
RNA-61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RNA-62	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RNA-63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RNA-64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RNA-65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RNA-66	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
RNA-67	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
RNA-68	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
RNA-69	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
RNA-70	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
RNA-3575	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RNA-3642	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RNA-6100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 6.3. Point-count data for the thin-sectioned sherds.

D. Volcanic and sedimentary lithic fragments

	Volcanic Lithic Fragments						Sedimentary Lithic Fragments							
Sample No.	Lvf	Lvfb	Lvi	Lvm	Lvv	Lvh	Lss	Lsa	Lsch	Lsca	Lsca1	Lsca2	Lsca3	Caco
RNA2-01	6	1	1	1	1	0	0	0	0	2	2	0	0	0
RNA2-02	28	6	9	3	5	1	0	1	4	47	1	1	45	0
RNA2-03	3	1	14	0	3	2	0	0	2	2	2	0	0	2
RNA2-04	86	52	0	1	6	0	0	0	2	0	0	0	0	0
RNA2-05	12	2	4	2	7	1	2	0	2	8	7	1	0	1
RNA2-06	12	1	7	2	4	1	3	0	3	4	3	1	0	0
RNA2-07	16	6	6	3	7	0	1	0	1	5	1	4	0	0
RNA2-08	12	8	5	2	8	1	1	0	2	15	10	5	0	0
RNA2-09	22	7	8	1	3	1	1	0	1	9	5	4	0	0
RNA2-10	18	11	6	5	6	0	2	0	3	15	7	8	0	0
RNA2-11	12	7	3	1	4	1	1	0	3	4	3	1	0	0
RNA2-12	11	7	4	2	3	2	0	0	3	6	3	3	0	0
RNA2-13	48	9	1	1	2	0	1	0	5	2	2	0	0	0
RNA2-14	61	4	1	1	4	0	0	0	4	4	4	0	0	0
RNA2-15	61	3	2	0	4	0	0	0	1	9	5	4	0	0
RNA2-16	36	9	1	0	2	1	0	0	2	1	1	0	0	0
RNA2-17	26	44	0	0	9	2	0	0	1	1	1	0	0	0
RNA2-18	44	16	1	2	9	1	0	0	2	11	2	9	0	0
RNA2-19	73	18	1	1	3	0	0	0	1	0	0	0	0	0
RNA2-20	55	20	3	0	7	0	0	0	6	2	1	1	0	0
RNA2-21	10	2	1	0	3	0	0	0	2	4	2	2	0	1
RNA2-22	0	0	1	0	0	3	0	0	0	9	7	2	0	0
RNA2-23	29	20	4	2	6	6	0	0	2	3	2	1	0	0
RNA2-24	24	13	3	0	4	2	0	0	0	1	1	0	0	0
RNA-39	4	1	2	0	0	0	0	0	4	0	2	2	0	0
RNA-40	15	11	5	1	2	5	0	0	2	2	3	0	0	0
RNA-41	4	3	1	0	0	2	0	0	7	4	2	0	0	3
RNA-42	18	2	5	0	3	38	1	0	1	3	2	4	0	1
RNA-43	173	4	0	0	1	0	0	0	0	2	2	0	0	0

Table 6.3. D. Continued.

Sample No.	Volcanic Lithic Fragments						Sedimentary Lithic Fragments							
	Lvf	Lvfb	Lvi	Lvm	Lvv	Lvh	Lss	Lsa	Lsch	Lsca	Lsca1	Lsca2	Lsca3	Caco
RNA-44	11	5	4	0	3	0	0	0	4	6	4	0	0	0
RNA-45	5	2	2	0	1	0	1	0	2	2	6	3	0	0
RNA-46	11	3	17	1	4	0	1	0	3	4	1	0	0	0
RNA-47	6	1	3	1	3	0	1	0	4	9	2	2	0	2
RNA-48	5	1	7	4	0	12	0	0	2	1	0	3	0	0
RNA-49	14	0	10	3	5	2	1	0	3	4	2	0	0	0
RNA-50	9	4	7	1	3	0	0	0	2	3	0	3	0	0
RNA-51	18	2	0	0	0	3	0	0	0	2	6	0	0	0
RNA-52	44	2	0	0	0	0	0	0	0	3	4	0	0	0
RNA-53	118	6	0	0	2	2	0	0	0	6	3	0	0	0
RNA-54	91	0	1	0	0	0	0	0	0	4	5	0	0	0
RNA-55	81	23	0	0	0	0	0	0	0	3	7	0	0	0
RNA-56	72	20	0	0	2	1	0	0	0	5	5	0	0	0
RNA-57	34	17	0	0	1	2	0	0	0	7	19	0	0	0
RNA-58	1	0	0	0	1	4	0	0	0	5	36	0	0	0
RNA-59	3	0	0	0	0	1	0	0	0	19	1	0	0	0
RNA-60	19	1	2	0	5	3	0	0	2	36	7	0	0	0
RNA-61	2	0	0	0	0	1	0	0	0	1	3	0	0	0
RNA-62	4	0	0	0	0	2	0	0	0	7	1	0	0	0
RNA-63	2	0	0	0	0	1	0	0	0	3	10	0	0	0
RNA-64	0	0	0	0	0	0	0	0	0	14	5	0	0	0
RNA-65	2	1	0	0	0	2	0	0	0	1	3	0	0	0
RNA-66	2	0	0	0	0	5	0	0	1	10	2	0	0	0
RNA-67	1	0	1	0	0	4	0	0	0	5	3	0	0	0
RNA-68	0	0	0	0	0	2	0	0	1	3	1	0	0	1
RNA-69	0	0	1	0	0	3	0	0	2	2	1	0	0	0
RNA-70	0	0	0	0	0	4	0	0	0	3	3	0	0	0
RNA-3575	0	0	0	0	0	0	0	0	0	1	0	0	0	0
RNA-3642	0	0	0	0	0	0	0	0	0	1	2	0	0	0
RNA-6100	0	1	1	0	0	3	0	0	0	3	14	0	0	0

Table 6.4. Qualitative data for the thin-sectioned sherds from the Rio Nuevo Archaeology project.

A. Fine fraction characteristics

Sample No.	Matrix Opacity[a]	Silt Fraction 1	Silt Fraction 2	Silt Fraction 3	Clay Fraction 1	Clay Fraction 2	Lumps in Matrix?
RNA2-01	2	Quartz	Biotite	Plagioclase feldspar	Quartz and/or feldspars	Biotite	Several
RNA2-02	2	Quartz	Plagioclase feldspar	Opaque oxides	Quartz and/or feldspars	Biotite	Few
RNA2-03	3	Quartz	Feldspar	Micas	Quartz	Opaque oxides	Several
RNA2-04	2	Quartz	Biotite	Opaque oxides	Quartz and/or feldspars	Biotite	None
RNA2-05	3	Quartz	Plagioclase feldspar	Biotite	Quartz and/or feldspars	Micas	Few
RNA2-06	3	Quartz	Plagioclase feldspar	Potassium feldspar	Quartz and/or feldspars	Feldspar	None
RNA2-07	3	Quartz	Plagioclase feldspar	Opaque oxides	Quartz and/or feldspars	Biotite	None
RNA2-08	3	Quartz	Plagioclase feldspar	Opaque oxides	Quartz and/or feldspars	Biotite	Few
RNA2-09	2	Quartz	Plagioclase feldspar	Opaque oxides	Quartz and/or feldspars	Biotite	Few
RNA2-10	3	Quartz	Plagioclase feldspar	Opaque oxides	Quartz	Feldspar	Few
RNA2-11	3	Quartz	Plagioclase feldspar	Potassium feldspar	Quartz and/or feldspars	Biotite	None
RNA2-12	3	Quartz	Plagioclase feldspar	Chlorite	Quartz and/or feldspars	Micas	Few
RNA2-13	3	Quartz	Plagioclase feldspar	Opaque oxides	Quartz and/or feldspars	Micas	Several
RNA2-14	3	Quartz	Plagioclase feldspar	Opaque oxides	Quartz and/or feldspars	Micas	Several
RNA2-15	1	Quartz	Micas	Quartz and/or feldspars	Quartz and/or feldspars	Micas	Zoned and mottled
RNA2-16	3	Quartz	Plagioclase feldspar	Opaque oxides	Quartz and/or feldspars	Micas	Few
RNA2-18	3	Quartz	Plagioclase feldspar	Biotite	Quartz and/or feldspars	Micas	Few

Table 6.4. A. Continued.

Sample No.	Matrix Opacity[a]	Silt Fraction 1	Silt Fraction 2	Silt Fraction 3	Clay Fraction 1	Clay Fraction 2	Lumps in Matrix?
RNA2-19	2	Quartz	Plagioclase feldspar	Opaque oxides	Quartz and/or feldspars	Micas	None
RNA2-20	2	Quartz	Biotite	Plagioclase feldspar	Quartz and/or feldspars	Micas	Zoned, mottled, lumpy, and otherwise highly heterogeneous
RNA2-21	3	Quartz	Biotite	Plagioclase feldspar	Quartz and/or feldspars	Micas	Few
RNA2-22	3	Quartz	Microcline	Opaque oxides	Quartz	Feldspar	Few
RNA2-23	1	Quartz	Feldspar	Opaque oxides	Quartz and/or feldspars	Opaque oxides	Several
RNA2-24	3	Quartz	Feldspar	Opaque oxides	Feldspar	Micas	Few
RNA-39	3	Quartz and/or feldspars	Biotite	Opaque oxides	Quartz and/or feldspars	Micas	Few
RNA-40	3	Quartz	Plagioclase feldspar	Potassium feldspar	Quartz	Quartz and/or feldspars	None
RNA-41	3	Quartz	Plagioclase feldspar	Potassium feldspar	Quartz	Quartz and/or feldspars	Few
RNA-42	3	Quartz	Plagioclase feldspar	Opaque oxides	Quartz	Feldspar	Few
RNA-43	2	Quartz	Plagioclase feldspar	Opaque oxides	Quartz and/or feldspars	Micas	None
RNA-44	2	Quartz	Biotite	Opaque oxides	Quartz and/or feldspars	Micas	Few
RNA-45	3	Quartz	Plagioclase feldspar	Opaque oxides	Quartz and/or feldspars	Opaque oxides	Few
RNA-46	3	Plagioclase feldspar	Quartz	Opaque oxides	Quartz	Quartz and/or feldspars	Few
RNA-47	3	Quartz	Plagioclase feldspar	Potassium feldspar	Quartz and/or feldspars	Micas	Few
RNA-48	3	Quartz	Plagioclase feldspar	Opaque oxides	Quartz and/or feldspars	Opaque oxides	Few
RNA-49	2	Quartz	Plagioclase feldspar	Opaque oxides	Micas	Quartz and/or feldspars	None
RNA-50	3	Plagioclase feldspar	Quartz	Biotite	Quartz and/or feldspars	Biotite	None
RNA-51	2	Quartz	Plagioclase feldspar	Opaque oxides	Quartz and/or feldspars	Micas	None

Table 6.4. A. Continued.

Sample No.	Matrix Opacity[a]	Silt Fraction 1	Silt Fraction 2	Silt Fraction 3	Clay Fraction 1	Clay Fraction 2	Lumps in Matrix?
RNA-52	2	Quartz	Plagioclase feldspar	Opaque oxides	Quartz and/or feldspars	Micas	None
RNA-53	1	Quartz	Plagioclase feldspar	Opaque oxides	Quartz and/or feldspars	Micas	Few
RNA-54	2	Quartz	Plagioclase feldspar	Potassium feldspar	Quartz and/or feldspars	Micas	None
RNA-55	2	Plagioclase feldspar	Quartz	Chlorite	Quartz	Plagioclase feldspar	Few
RNA-56	2	Quartz	Plagioclase feldspar	Opaque oxides	Quartz and/or feldspars	Micas	None
RNA-57	2	Quartz	Plagioclase feldspar	Opaque oxides	Quartz and/or feldspars	Micas	None
RNA-58	1	Plagioclase feldspar	Quartz	Potassium feldspar	Quartz	Feldspar	Few
RNA-59	1	Plagioclase feldspar	Quartz	Opaque oxides	Quartz and/or feldspars	Opaque oxides	None
RNA-60	2	Quartz	Plagioclase feldspar	Micas	Quartz and/or feldspars	Opaque oxides	None
RNA-61	1	Plagioclase feldspar	Quartz	Pyroxene or amphibole	Quartz and/or feldspars	Opaque oxides	None
RNA-62	1	Plagioclase feldspar	Quartz	Potassium feldspar	Quartz and/or feldspars	Opaque oxides	None
RNA-63	1	Plagioclase feldspar	Quartz	Potassium feldspar	Quartz	Feldspar	Few
RNA-64	1	Quartz	Plagioclase feldspar	Feldspar	Quartz and/or feldspars	Opaque oxides	Several
RNA-65	1	Quartz	Plagioclase feldspar	Opaque oxides	Quartz	Feldspar	None
RNA-66	1	Quartz	Plagioclase feldspar	Potassium feldspar	Feldspar	Micas	Few
RNA-67	1	Quartz	Plagioclase feldspar	Micas	Feldspar	Micas	Few
RNA-68	1	Quartz	Plagioclase feldspar	Potassium feldspar	Quartz and/or feldspars	Micas	Few
RNA-69	2	Quartz	Plagioclase feldspar	Potassium feldspar	Feldspar	Opaque oxides	Few
RNA-70	1	Quartz	Plagioclase feldspar	Potassium feldspar	Feldspar	Micas	Few

[a]Matrix opacity is expressed as an integer from 0 = opaque to 9 = transparent.

Table 6.4. Qualitative data for the thin-sectioned sherds from the Rio Nuevo Archaeology project.

B. Sand fraction characteristics

Sample No.	Finest (mm)	Coarsest (mm)	Mode (mm)	Sorting	Dominant Coarse Grain	Accessory Mineral 1	Accessory Mineral 2	Accessory Mineral 3
RNA2-01	Silt (<0.0625)	Very coarse sand (1.0-2.0)	Bimodal	Bimodal	Quartz	Opaque oxides	Plagioclase feldspar	Biotite
RNA2-02	Silt (<0.0625)	Granule (>2.0)	Bimodal	Bimodal	Quartz	Opaque oxides	Biotite and chlorite	Plagioclase feldspar
RNA2-03	Silt (<0.0625)	Granule (>2.0)	Bimodal	Bimodal	Quartz	Opaque oxides	Plagioclase feldspar	Biotite and chlorite
RNA2-04	Silt (<0.0625)	Granule (>2.0)	Bimodal	Bimodal	Tuff of Beehive Peak	Tuff of Beehive Peak	Quartz	Plagioclase feldspar
RNA2-05	Silt (<0.0625)	Granule (>2.0)	Bimodal	Bimodal	Quartz	Microcline	Opaque oxides	Plagioclase feldspar
RNA2-06	Silt (<0.0625)	Granule (>2.0)	Bimodal	Bimodal	Quartz	Plagioclase feldspar	Feldspar	Tuff of Beehive Peak
RNA2-07	Silt (<0.0625)	Granule (>2.0)	Bimodal	Bimodal	Quartz	Plagioclase feldspar	Opaque oxides	Potassium feldspar
RNA2-08	Silt (<0.0625)	Granule (>2.0)	Bimodal	Bimodal	Quartz	Plagioclase feldspar	Biotite	Microcline
RNA2-09	Silt (<0.0625)	Granule (>2.0)	Bimodal	Bimodal	Quartz	Plagioclase feldspar	Opaque oxides	Potassium feldspar
RNA2-10	Silt (<0.0625)	Granule (>2.0)	Bimodal	Bimodal	Quartz	Plagioclase feldspar	Opaque oxides	Altered/Chloritized mafics
RNA2-11	Silt (<0.0625)	Granule (>2.0)	Bimodal	Bimodal	Plagioclase feldspar	Quartz	Biotite and chlorite	—
RNA2-12	Silt (<0.0625)	Granule (>2.0)	Bimodal	Bimodal	Quartz	Plagioclase feldspar	Biotite and chlorite	Potassium feldspar
RNA2-13	Silt (<0.0625)	Granule (>2.0)	Bimodal	Bimodal	Quartz	Tuff of Beehive Peak	Hypabyssal volcanic, "dirty snowballs"	Plagioclase feldspar
RNA2-14	Silt (<0.0625)	Granule (>2.0)	Bimodal	Bimodal	Quartz	Plagioclase feldspar	Tuff of Beehive Peak	Opaque oxides
RNA2-15	Silt (<0.0625)	Granule (>2.0)	Bimodal	Bimodal	Quartz	Grog	Opaque oxides	Plagioclase feldspar
RNA2-16	Silt (<0.0625)	Granule (>2.0)	Bimodal	Bimodal	Quartz	Tuff of Beehive Peak	Opaque oxides	Sherd temper of various sorts
RNA2-18	Silt (<0.0625)	Granule (>2.0)	Bimodal	Bimodal	Quartz	Tuff of Beehive Peak	Plagioclase feldspar	Biotite and chlorite

Table 6.4. B. Continued.

Sample No.	Finest (mm)	Coarsest (mm)	Mode (mm)	Sorting	Dominant Coarse Grain	Accessory Mineral 1	Accessory Mineral 2	Accessory Mineral 3
RNA2-19	Silt (<0.0625)	Granule (>2.0)	Bimodal	Bimodal	Quartz	Tuff of Beehive Peak	Plagioclase feldspar	Opaque oxides
RNA2-20	Silt (<0.0625)	Granule (>2.0)	Bimodal	Bimodal	Quartz	Plagioclase feldspar	Opaque oxides	Micas
RNA2-21	Silt (<0.0625)	Granule (>2.0)	Bimodal	Bimodal	Quartz	Fiber, non-specific	Biotite	Plagioclase feldspar
RNA2-22	Silt (<0.0625)	Granule (>2.0)	Bimodal	Bimodal	Quartz	Microcline	Fiber, non-specific	Plagioclase feldspar
RNA2-23	Silt (<0.0625)	Granule (>2.0)	Bimodal	Bimodal	Quartz	Fiber, non-specific	Plagioclase feldspar	Opaque oxides
RNA2-24	Silt (<0.0625)	Granule (>2.0)	Bimodal	Bimodal	Quartz	Plagioclase feldspar	Opaque oxides	Microcline
RNA-39	Silt (<0.0625)	Granule (>2.0)	Bimodal	Bimodal	Quartz	Plagioclase feldspar	Potassium feldspar	Opaque oxides
RNA-40	Silt (<0.0625)	Granule (>2.0)	Bimodal	Bimodal	Quartz	Plagioclase feldspar	–	–
RNA-41	Silt (<0.0625)	Granule (>2.0)	Bimodal	Bimodal	Plagioclase feldspar	Quartz	–	–
RNA-42	Silt (<0.0625)	Granule (>2.0)	Bimodal	Bimodal	Hypabyssal volcanic, "dirty snowballs"	Quartz	Plagioclase feldspar	Opaque oxides
RNA-43	Silt (<0.0625)	Very coarse sand (1.0-2.0)	Coarse sand (0.50-1.00)	Moderately well	Hypabyssal volcanic, "dirty snowballs"	Quartz	Plagioclase feldspar	Opaque oxides
RNA-44	Silt (<0.0625)	Granule (>2.0)	Bimodal	Bimodal	Quartz	Plagioclase feldspar	–	–
RNA-45	Silt (<0.0625)	Granule (>2.0)	Bimodal	Bimodal	Quartz	Plagioclase feldspar	Potassium feldspar	Opaque oxides
RNA-46	Silt (<0.0625)	Granule (>2.0)	Bimodal	Bimodal	Plagioclase feldspar	Quartz	Opaque oxides	Amphibole
RNA-47	Silt (<0.0625)	Granule (>2.0)	Bimodal	Bimodal	Quartz	Plagioclase feldspar	Potassium feldspar	Biotite and chlorite
RNA-48	Silt (<0.0625)	Granule (>2.0)	Bimodal	Bimodal	Plagioclase feldspar	Quartz	Opaque oxides	Potassium feldspar
RNA-49	Silt (<0.0625)	Granule (>2.0)	Bimodal	Bimodal	Quartz	Plagioclase feldspar	Schist	Potassium feldspar
RNA-50	Silt (<0.0625)	Granule (>2.0)	Bimodal	Bimodal	Plagioclase feldspar	Quartz	Biotite	Potassium feldspar
RNA-51	Silt (<0.0625)	Very coarse sand (1.0-2.0)	Coarse sand (0.50-1.00)	Moderately poor	Quartz	Plagioclase feldspar	Microcline	Opaque oxides

Table 6.4. B. Continued.

Sample No.	Finest (mm)	Coarsest (mm)	Mode (mm)	Sorting	Dominant Coarse Grain	Accessory Mineral 1	Accessory Mineral 2	Accessory Mineral 3
RNA-52	Silt (<0.0625)	Very coarse sand (1.0-2.0)	Coarse sand (0.50-1.00)	Moderately sorted	Quartz	Plagioclase feldspar	Undifferentiated felsic volcanic	Opaque oxides
RNA-53	Silt (<0.0625)	Granule (>2.0)	Very coarse sand (1.00-2.00)	Moderately sorted	Undifferentiated felsic volcanic	Quartz	Grog	Opaque oxides
RNA-54	Silt (<0.0625)	Granule (>2.0)	Very coarse sand (1.00-2.00)	Moderately poor	Quartz	Plagioclase feldspar	Undifferentiated felsic volcanic	Opaque oxides
RNA-55	Silt (<0.0625)	Very coarse sand (1.0-2.0)	Bimodal	Bimodal	Plagioclase feldspar	Potassium feldspar	Undifferentiated felsic volcanic	Biotite and chlorite
RNA-56	Silt (<0.0625)	Very coarse sand (1.0-2.0)	Very coarse sand (1.00-2.00)	Moderately sorted	Quartz	Plagioclase feldspar	Undifferentiated felsic volcanic	Opaque oxides
RNA-57	Silt (<0.0625)	Granule (>2.0)	Very coarse sand (1.00-2.00)	Moderately well	Plagioclase feldspar	Quartz	Microcline	Biotite and chlorite
RNA-58	Silt (<0.0625)	Granule (>2.0)	Very coarse sand (1.00-2.00)	Moderately sorted	Microcline	Quartz	Plagioclase feldspar	Caliche; granular carbonate grains
RNA-59	Silt (<0.0625)	Granule (>2.0)	Coarse sand (0.50-1.00)	Moderately sorted	Plagioclase feldspar	Microcline	Quartz	Granite
RNA-60	Silt (<0.0625)	Granule (>2.0)	Coarse sand (0.50-1.00)	Moderately poor	Potassium feldspar	Plagioclase feldspar	Quartz	Undifferentiated felsic volcanic
RNA-61	Silt (<0.0625)	Granule (>2.0)	Coarse sand (0.50-1.00)	Moderately poor	Plagioclase feldspar	Microcline	Quartz	Granite
RNA-62	Silt (<0.0625)	Granule (>2.0)	Coarse sand (0.50-1.00)	Poorly sorted	Plagioclase feldspar	Microcline	Quartz	Unknown
RNA-63	Silt (<0.0625)	Granule (>2.0)	Very coarse sand (1.00-2.00)	Moderately poor	Microcline	Plagioclase feldspar	Quartz	Granite
RNA-64	Silt (<0.0625)	Granule (>2.0)	Very coarse sand (1.00-2.00)	Moderately poor	Microcline	Plagioclase feldspar	Quartz	Clay lumps
RNA-65	Silt (<0.0625)	Very coarse sand (1.0-2.0)	Medium sand (0.25-0.50)	Moderately poor	Microcline	Plagioclase feldspar	Quartz	Granite
RNA-66	Silt (<0.0625)	Granule (>2.0)	Bimodal	Bimodal	Plagioclase feldspar	Fiber, non-specific	Quartz	Microcline
RNA-67	Silt (<0.0625)	Granule (>2.0)	Bimodal	Bimodal	Quartz	Fiber, non-specific	Micas	Plagioclase feldspar
RNA-68	Silt (<0.0625)	Granule (>2.0)	Bimodal	Bimodal	Quartz	Fiber, non-specific	Microcline	Plagioclase feldspar
RNA-69	Silt (<0.0625)	Granule (>2.0)	Bimodal	Bimodal	Plagioclase feldspar	Fiber, non-specific	Quartz	Microcline
RNA-70	Silt (<0.0625)	Granule (>2.0)	Bimodal	Bimodal	Plagioclase feldspar	Fiber, non-specific	Quartz	Microcline

Temper Type Analysis

The diverse assortment of temper types in this set of sherds requires additional explanation (see Table 6.4). In addition to sand temper, sherds with sand plus grog and sand plus fiber temper were encountered. In all but one of the 56 thin sections, the ceramicist's assessment of temper type concurs with that seen under the petrographic microscope (Table 6.5). The single exception is RNA-44, a very fine-grained sherd with a dark paste. In this sherd, fiber temper is clearly visible in the thin section, but the fibers are small and the paste is very dark, making it impossible to see the fiber voids under the low-powered binocular stereomicroscope. Additionally, the petrographers characterized some tempers as "sandy clay" or "sandy clay plus fiber" instead of the ceramicist's characterization of "sand" and "sand plus fiber." These more detailed characterizations under the petrographic microscope reflect the presence of crushing features on the sand grains—features that are only visible in thin section. Thus, the ceramicist's "sand" is equivalent to the petrographers' "sandy clay." A more complete discussion of the anthropological and statistical implications of the use of sand versus sandy clay is found later in this chapter.

Statistical Implications of Temper Type Variations

With sand-tempered sherds, the sand temper data are simply submitted for analysis. With more complex mixtures—for example, sand plus grog—the non-sand phase must be excluded from consideration during the statistical analysis process. For the Rio Nuevo sherds, the following statistical adaptations were used.

The sand-tempered sherds in the Tucson Basin are straightforward; therefore, all sand-sized grains are counted. A record of the number of matrix and voids encountered while counting is kept, making a full volumetric composition of the paste available. Figure 6.2 is a photomicrograph of a Beehive Petrofacies sand-tempered sherd, illustrating common grain sizes and shapes for sand-tempered sherds.

The sand plus grog-tempered sherds in the Tucson Basin commonly have sand temper in the grog (Figure 6.3). Thus, anything that may be encountered within the grog grain was counted as "grog," although a separate list of grog composition was collected. The grog is not included in the compositional analysis of the sand temper for provenance analysis.

The fiber-tempered sherds in the Tucson Basin commonly have large, elongated voids, frequently with charred remains of plant material (Figures 6.4-6.6). The plant structure is sometimes retained, and the voids may also have dark, carbonized margins. When counting, the characteristic fiber voids are tallied separately from the "bubble" voids commonly seen in ceramics. Voids are not included in the statistical provenance analyses of sand. Ethnographic evidence indicates the source of the fiber in these ceramics is manure, presumably horse manure (Fontana et al. 1962).

In addition to the fiber, all the fiber-tempered pottery also contains sand. This sand could be added intentionally, although it is more likely a component of the clay selected for pottery production. Ethnographic research conducted in the mid-twentieth century indicates pedologically derived clays forming on alluvial parent material were a common source for local historic Native American potters (Fontana et al. 1962:Figure 41). These materials are rich in sand-sized grains. The clays were ground up (Fontana et al. 1963:Figure 42), then horse manure was added to make the clay paste. We have noted crushing features on the sand grains in the fiber-tempered pottery, which supports the ethnographic reports. Compositionally, the sands naturally included in these clays are directly related to their provenance. However, their composition may differ slightly from our reference sands, which have experienced less chemical weathering than sediments subjected to soil formation. Behaviorally, the sand is not "temper;" that is, it was not added to the clay to change the properties of the material (Shepard 1995).

Finally, Whittlesey (1997) has suggested that some amount of sand may be introduced into the clay body from the horse manure. Although we have collected horse manure to test this hypothesis, we are still debating a suitable method for extracting and quantifying sand fraction that may be included in the manure. Visually, sparse grains of sand can be seen in the manure, but the quantity introduced into the clay body would be volumetrically very low.

For comparison, three ethnographic samples of raw and prepared clay were obtained from the Arizona State Museum (ASM). One of the samples is from the San Xavier area; the remaining samples are from farther west on the Tohono O'odham Reservation. All three samples were collected and prepared by O'odham potters (Fontana et al. 1962: 142-143). Test briquettes were made from the samples; these were subsequently thin sectioned and point counted (Figures 6.7-6.8). The raw clay sample contains 33 percent sand, while the prepared clay samples, which have added manure, have 35-36 percent sand. All three samples are at the high end of sand content compared with the fiber-tempered archaeological pottery, which ranges from 20-38 percent sand, with a mean of 27 percent (Figure 6.9). Visual examination of horse manure and the point-count data from ethnographic samples suggest a small amount of

Table 6.5. Comparison of temper type assessments made by the ceramicist (low magnification) and the petrographers (high magnification) for sherds from the Rio Nuevo Archaeology project.

Sample Number	Ceramic Type	Ceramicist's Temper Type	Petrographer's Temper Type	Results
RNA2-01	Indeterminate red	Sand	Sandy clay	Agree
RNA2-02	Indeterminate red	Sand	Sand	Agree
RNA2-03	Indeterminate red	Sand	Sand	Agree
RNA2-04	Unspecified plain ware	Sand	Sand	Agree
RNA2-05	Indeterminate red	Sand	Sand	Agree
RNA2-06	Indeterminate red	Sand	Sand	Agree
RNA2-07	Unspecified plain ware	Sand	Sand	Agree
RNA2-08	Indeterminate red	Sand	Sand	Agree
RNA2-09	Indeterminate red	Sand	Sand	Agree
RNA2-10	Indeterminate red	Sand	Sand	Agree
RNA2-11	Indeterminate red	Sand	Sand	Agree
RNA2-12	Indeterminate red	Sand	Sandy clay	Agree
RNA2-13	Indeterminate red	Sand plus grog	Sand plus grog	Agree
RNA2-14	Indeterminate red	Sand plus grog	Sand plus grog	Agree
RNA2-15	Indeterminate red	Sand plus grog	Sandy clay plus grog	Agree
RNA2-16	Indeterminate red	Sand plus grog	Sand plus grog	Agree
RNA2-17	Sobaipuri Plain (folded rim)	Sand plus grog	Sand plus grog	Agree
RNA2-18	Unspecified plain ware	Sand plus grog	Sand plus grog	Agree
RNA2-19	Unspecified plain ware	Sand plus grog	Sand	Agree
RNA2-20	Unspecified plain ware	Sand plus grog	Sandy clay plus grog	Agree
RNA2-21	Papago Plain	Sand plus manure/fiber	Sand plus manure/fiber	Agree
RNA2-22	Papago Red	Sand plus manure/fiber	Sand plus manure/fiber	Agree
RNA2-23	Papago Red	Sand plus manure/fiber	Sand plus manure/fiber	Agree
RNA2-24	Indeterminate red	Sand	Sand	Agree
RNA-39	Sobaipuri Plain (folded rim)	Sand	Sand	Agree
RNA-40	Unspecified plain ware	Sand	Sand	Agree
RNA-41	Sobaipuri Plain (folded rim)	Sand	Sand	Agree
RNA-42	Unspecified plain ware	Sand	Sand	Agree
RNA-43	Unspecified plain ware	Sand plus grog	Sand plus grog	Agree
RNA-44	Papago Red	Sand	Sand plus manure/fiber	Disagree
RNA-45	Papago Plain	Sand	Sand	Agree
RNA-46	Unspecified plain ware	Sand	Sandy clay	Agree
RNA-47	Indeterminate red	Sand	Sand	Agree
RNA-48	Unspecified plain ware	Sand	Sandy clay	Agree
RNA-49	Sobaipuri Plain (folded rim)	Sand	Sandy clay	Agree
RNA-50	Unspecified plain ware	Sand	Sandy clay	Agree
RNA-51	Sobaipuri Plain (folded rim)	Sand plus grog	Sand plus grog	Agree
RNA-52	Sobaipuri Plain (folded rim)	Sand plus grog	Sandy clay plus grog	Agree
RNA-53	Unspecified plain ware	Sand plus grog	Sand plus grog	Agree
RNA-54	Indeterminate red	Sand plus grog	Sandy clay plus grog	Agree
RNA-55	Sobaipuri Plain (folded rim)	Sand plus grog	Sand plus grog	Agree
RNA-56	Unspecified plain ware	Sand plus grog	Sand plus grog	Agree
RNA-57	Indeterminate red	Sand plus grog	Sand plus grog	Agree

Table 6.5. Continued.

Sample Number	Ceramic Type	Ceramicist's Temper Type	Petrographer's Temper Type	Results
RNA-58	Papago Plain	Sand plus manure/fiber	Sand plus manure/fiber	Agree
RNA-59	Papago Red	Sand plus manure/fiber	Sand plus manure/fiber	Agree
RNA-60	Papago Red	Sand plus manure/fiber	Sand plus manure/fiber	Agree
RNA-61	Papago Plain	Sand plus manure/fiber	Sand plus manure/fiber	Agree
RNA-62	Papago Plain	Sand plus manure/fiber	Sand plus manure/fiber	Agree
RNA-63	Papago Red	Sand plus manure/fiber	Sand plus manure/fiber	Agree
RNA-64	Papago Plain	Sand plus manure/fiber	Sand plus manure/fiber	Agree
RNA-65	Papago Red	Sand plus manure/fiber	Sand plus manure/fiber	Agree
RNA-66	Papago Plain	Sand plus manure/fiber	Sand plus manure/fiber	Agree
RNA-67	Papago Plain	Sand plus manure/fiber	Sand plus manure/fiber	Agree
RNA-68	Papago Red	Sand plus manure/fiber	Sand plus manure/fiber	Agree
RNA-69	Papago Plain	Sand plus manure/fiber	Sand plus manure/fiber	Agree
RNA-70	Papago Plain	Sand plus manure/fiber	Sand plus manure/fiber	Agree

sand could have been introduced into the paste from manure temper, although the bulk of the sand-sized grains in the temper were probably a natural component of the clay.

Behavioral Implications of the Material Types

After full consideration of the data, we included all sand-sized grains from fiber-tempered pottery in our statistical analysis, on the assumption that the sand is predominantly derived from the clay itself, and that it reflects the provenance of that material. We recognize that our sand samples may not be the perfect source material from which to match sandy clays derived from soils, but we assert that they are similar enough to compare statistically. Therefore, the sand in fiber-tempered pottery is treated as if it were sand temper for statistical purposes. However, the collection of sandy clays from soils is a different behavior than the collection of sand to temper clay.

Ethnographic examples collected from around the world show that potters sometimes collect clay resources from farther away than sand resources (Arnold 1985; Heidke 2006; Heidke et al. 2002; Heidke et al. 2006; Miksa and Heidke 1995). Most clays are collected within 4 km of the pottery production locations (Figure 6.10). An examination of a box-and-whiskers plot of 150 distance-to-clay resource measurements shows the median distance to clay as 2 km, with the upper hinge (75 percent) at 4 km. There are 16 outliers between 8 km and 50 km. Of these 16 outliers, only one is specified as foot transport of the material. The remaining distance-to-resource data do not list the specific mode of transport,

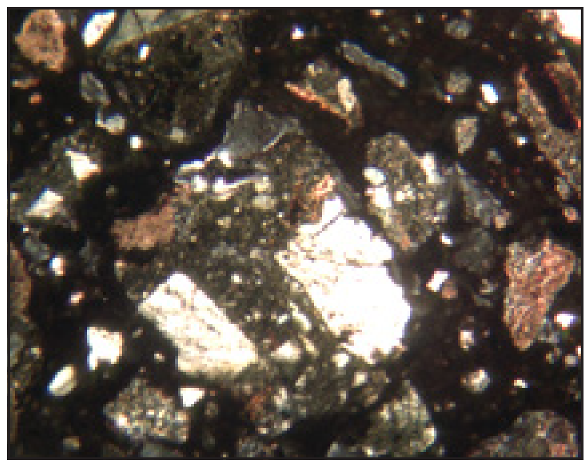

Figure 6.2. Photomicrograph of a Beehive Petrofacies sand-tempered sherd.

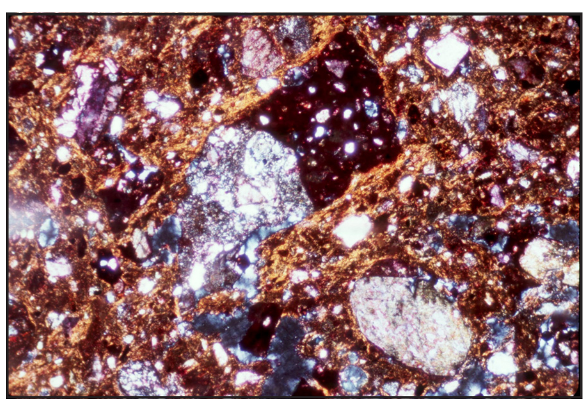

Figure 6.3. Photomicrograph of sherd RNA-52, tempered with Beehive Petrofacies sand plus grog. (Photograph was taken at 13.2x magnification under crossed nicols; note the sand temper in the dark grog fragment.)

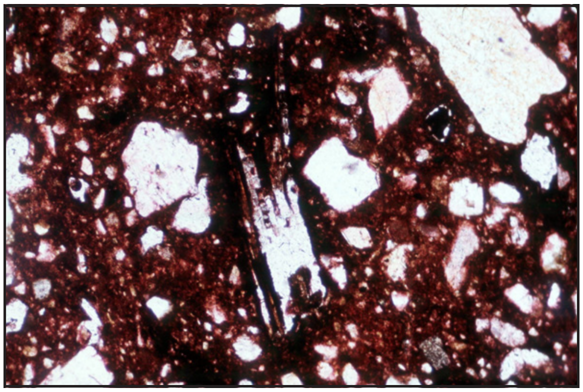

Figure 6.4. Photomicrograph of sherd RNA2-22, showing prismatic fiber voids, carbon rim, and some remnant fiber structure. (Photograph was taken at 13.2x magnification under plane polarized light.)

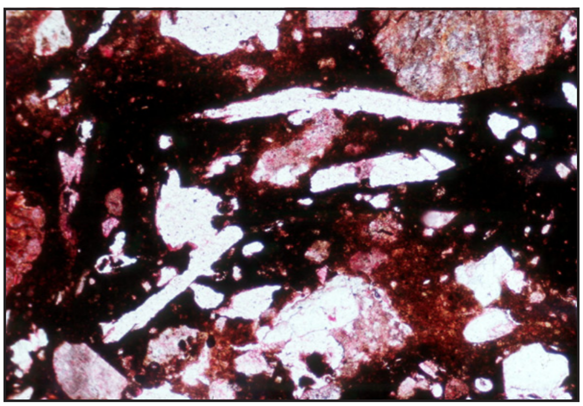

Figure 6.5. Photomicrograph of sherd RNA-44, showing elongated fiber voids, one of which is bent around a sand grain. (Photograph was taken at 13.2x magnification under plane polarized light.)

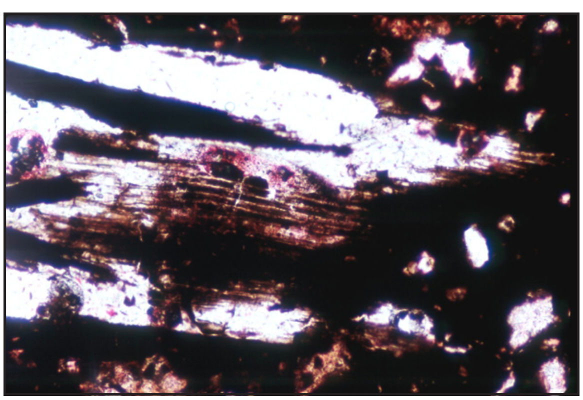

Figure 6.6. Photomicrograph of sherd RNA2-23, showing detail of a fiber void with remnant plant structure. (Photograph was taken at 33x magnification under crossed nicols.)

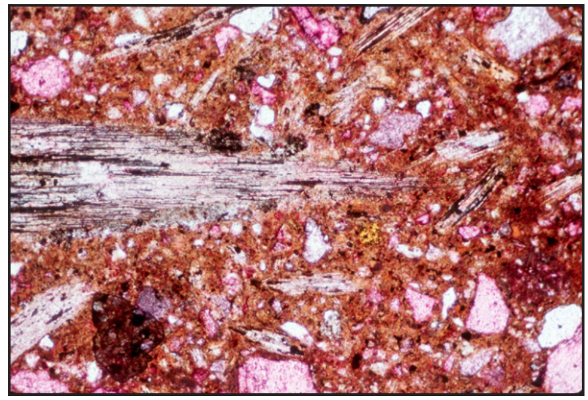

Figure 6.7. Photomicrograph of an unfired briquet made from an ethnographic collection of prepared clay (ASM number E6100) collected by Fontana et al. (1962). (Note the abundant fiber in the paste; photograph was taken at 13.2x magnification under plane polarized light.)

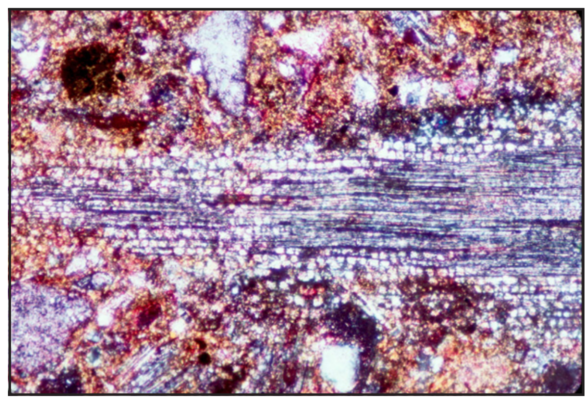

Figure 6.8. Photomicrograph of an unfired briquet made from an ethnographic collection of prepared clay (ASM number E6100) collected by Fontana et al. (1962). (Close-up of structural detail; photograph was taken at 33x magnification under cross polarized light.)

so some non-foot transport distances may be included (Heidke et al. 2006). Examination of the ethnographic and historic literature for O'odham and Sobaipuri potters of southern and western Arizona suggest their distance-to-clay resource measurements would have been within the 4 km estimate, at least while human labor was the primary mode of transportation. We use this distance in calculating clay procurement by historic Native American potters.

Temper Composition Analysis

Temper composition of the Rio Nuevo sherds was characterized by Heidke. Because only 56 of 2,373 characterized sherds were selected for thin-section analysis, the overall thin-section proportion for this data set is 2.4 percent (Table 6.6). This is approximately half the usual proportion of thin sections selected for verification purposes (Miksa and Heidke 2001). The low proportion is due to a number of circumstances. First, sherds assigned to the unspecified generic and specific temper composition group were not sampled due to their low information value. The high number of fine-grained or fiber-tempered historic sherds in this data set led to a high number of unspecified temper designations, because temper could not be distinguished at low, reflected light magnification. This group includes 666 of the 2,373 sherds, or 28 percent of the data set. This group was sampled at a deliberately low rate for this project, due to its low information value and the likelihood that the sherds belonged to multiple compositions.

Sherds belonging to the "Fine Paste" generic group were not thin sectioned due to their lack of sand-sized grains. Sherds assigned to the "Santan or Gila Butte Schist Plus Sand" and "Metamorphic Core Complex" generic groups, and the Catalina and Tortolita petrofacies, were not sampled because they represent a very low proportion of the complete data set.

The Twin Hills Petrofacies was sampled at a lower rate because Heidke has shown his ability to recognize these petrofacies on previous projects (Heidke 2000, 2003a, 2003b, 2006; Heidke et al. 1998). Although Heidke has demonstrated a similar success rate with the Beehive Petrofacies sand-tempered sherds, this group is still being sampled at a higher rate to explore the limits of this composition, especially at its southern edge where it meets the Black Mountain Petrofacies. Sherds assigned to the volcanic generic group with an unspecified petrofacies were sampled at a low rate, due to their lower information value and the likelihood that they would represent several petrofacies. In the remaining composition groups, sampling rates of approximately 4-10 percent were used to test the temper characterizations. This sampling rate is adequate to test the diversity of the sample and the accuracy of the ceramicist's temper characterizations within the sampled groups.

After the petrographic analysis was complete, sherds were submitted as unknowns for classification by the current Tucson Basin discriminant analysis model (Miksa 2006), following standard statistical analysis methods for point-counted sherds (Heidke and Miksa 2000; Miksa and Heidke 2001). The discriminant model used for this project considers only the 18 petrofacies in the Tucson Basin proper. It includes 243 sands, of which 214 are classified correctly by the model, for an accuracy of 88 percent. The model comprises nine nested discriminant analysis models. The output at each modeling level is used as the input for the next level, as detailed in Heidke and Miksa (2000). The point-count parameters and calculated parameters used in each level of the model are shown in Table 6.7, and a schematic view of how the nested models relate to each another is provided in Figure 6.11.

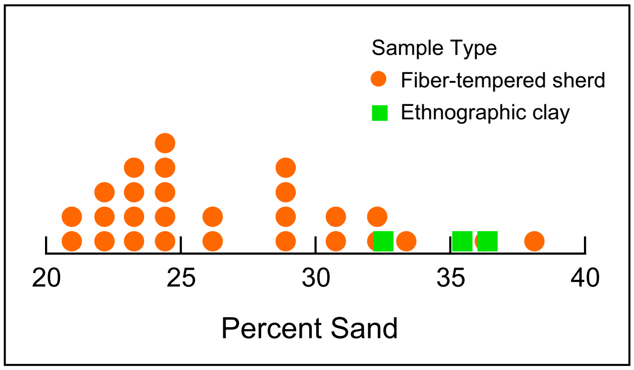

Figure 6.9. Dot density graph showing the proportion of sand in the sand plus fiber-tempered sherds versus the fiber-tempered ethnographically collected prepared clays.

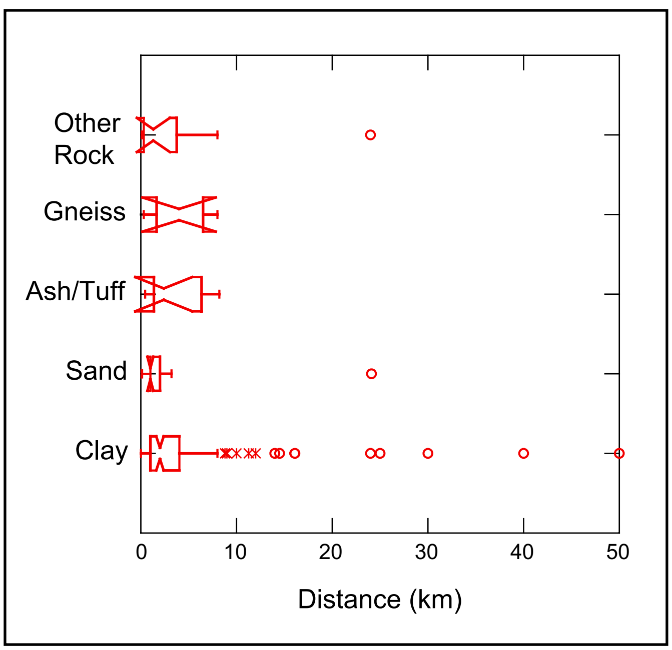

Figure 6.10. Ethnographic distance-to-resource measurements, by resource type.

Table 6.6. Proportion of thin sections by concatenated generic temper source and specific temper source groups, Rio Nuevo Archaeology project.

		Number of Sherds (number of thin sections) in the Detailed Ceramic Analysis Set, by Site[b]					
Generic Temper Source[a]	Specific Temper Source[a]	BB:13:13	BB:13:481	BB:13:6	Total Sherds	Total Thin Sections	Thin Section Proportion
Unspecified	Unspecified	82 (2)	13 (0)	571 (4)	666	6	0.9
Fine paste	Unspecified	0 (0)	4 (0)	91 (0)	95	0	0.0
Santan or Gila Butte schist plus sand	Unspecified	0 (0)	0 (0)	5 (0)	5	0	0.0
Metamorphic core complex	Catalina	0 (0)	0 (0)	11 (0)	11	0	0.0
Metamorphic core complex	Unspecified	0 (0)	0 (0)	15 (0)	15	0	0.0
Granitic	Unspecified	171 (15)	0 (0)	117 (2)	288	17	5.9
Granitic	Tortolita	0 (0)	0 (0)	3 (0)	3	0	0.0
Mixed volcanic and granitic	Unspecified	39 (4)	0 (0)	3 (0)	42	4	9.5
Granitic and mixed lithic	Santa Cruz River	0 (0)	0 (0)	239 (9)	239	9	3.8
Granitic and mixed lithic	Unspecified	25 (2)	0 (0)	1 (0)	26	2	7.7
Volcanic	Unspecified	17 (2)	0 (0)	390 (4)	407	6	1.5
Volcanic	Beehive	50 (5)	0 (0)	218 (5)	268	10	3.7
Volcanic	Twin Hills	12 (0)	0 (0)	296 (2)	308	2	0.6
Column totals		396 (30)	17 (0)	1,960 (26)	2,373	56	2.4

[a]From ceramicist's temper characterization.
[b]All sites are AZ # (ASM).

Results

Discriminant analysis results for the compositional analysis are shown in Table 6.8. Fifty-three of the 56 thin-sectioned sherds were given final petrofacies assignments. It is informative to examine the sherds in terms of the generic and specific temper groups assigned during the detailed analysis. Discriminant analysis assigns all submitted samples to the closest group in multidimensional space, even though the samples may be far from the closest group. Thus, discriminant assignments are checked for accuracy before a final petrofacies assignment is made.

The six sherds with both generic and specific temper source unspecified were difficult to classify even with quantitative petrographic data. One was thought to belong to the Rincon Petrofacies by the petrographer. The discriminant analysis also classified the sherd as Rincon Petrofacies, so the final assignment is accepted as Rincon Petrofacies. Two of the sherds have a final classification as indeterminate. The petrographer's temper assignment did not match that of the discriminant analysis, and after much additional inspection and comparison of composition proportions, none of the assignments could be affirmed as correct. Consequently, these sherds have "Indeterminate" temper classifications. One of the sherds was thought to be extrabasinal by the petrographers. It was assigned to the Airport Petrofacies in the discriminant analysis, but does not have any volcanic grain types in common with that petrofacies. The temper in this sherd bears some similarity to rocks located west of Avra Valley and should be compared with source materials from the Altar Valley should they become available. Finally, two of the unspecified sherds were thought to belong to the Black Mountain Petrofacies by the petrographer. Both were assigned to Black Mountain Petrofacies by the discriminant analysis. Their final assignment is Black Mountain Petrofacies.

Seventeen of the thin-sectioned sherds were assigned to the "Granitic Sand, Unspecified Petrofacies" group. These sherds come from historic Native American pots with fiber temper. The petrographers characterized them as coming from either the Black

Table 6.7. Point–count parameters and calculated parameters used for each discriminant analysis model.

	Family Level	Granitic-Metamorphic Generic Level	Granitic, Rich in Microcline	Granitic, Rich in Heavy Minerals	Volcanic, Generic Level	Volcanic, Rich in Feldspars	Volcanics Only, Generic Level	Tucson Mountains, East	Tucson Mountains, North and West
Petrofacies			*A, G, K, O, P*	*B, E1, E2, E3, S*		*Bv, I*		*J1, J2, J3*	*L, M, Mw*
TQtz	X	X	X	X	X	X	X	X	X
Kspar	X	–	–	–	–	–	–	X	–
Micr	X	X	X	–	–	–	–	X	–
TKspar	–	–	X	–	–	–	–	–	–
K	–	–	–	X	–	X	–	–	X
TPlag	X	–	X	X	–	X	X	X	X
TMusc	–	–	X	X	–	–	–	–	–
TBiotchlor	–	–	X	–	X	–	X	–	–
Mica	–	–	–	–	–	X	–	X	–
PlagPyr	–	X	–	–	–	–	–	–	–
TOpaq	–	–	X	–	X	–	–	X	–
PyrOpaq	–	–	–	X	–	–	–	–	–
Epid	–	X	X	X	–	–	–	–	–
Pyrepid	–	–	–	–	–	–	–	X	–
Hmin	X	–	–	–	–	X	–	–	–
Lma2	–	–	–	–	–	X	–	–	–
Lmmf	–	–	–	X	–	–	X	–	–
Lmatp	–	–	–	X	–	–	–	–	–
Lmmftp	–	–	–	–	–	X	–	–	–
Lm_Musc	–	X	–	–	–	–	–	–	–
Lm	X	–	X	–	X	–	–	–	–
Lvf2	–	–	X	–	–	X	–	–	X
Lvm2	–	–	–	–	–	X	–	–	X
Lvmf2	–	–	–	–	–	–	–	X	–
Lvv	–	–	–	–	–	–	–	X	–
Lvh	–	–	–	–	–	–	X	X	–
Lv	X	X	–	–	X	–	–	–	–
Ls	–	–	–	–	X	X	–	–	X
Lsclas	–	–	–	–	–	–	X	X	–
Lscaco	–	–	–	–	–	–	X	–	–

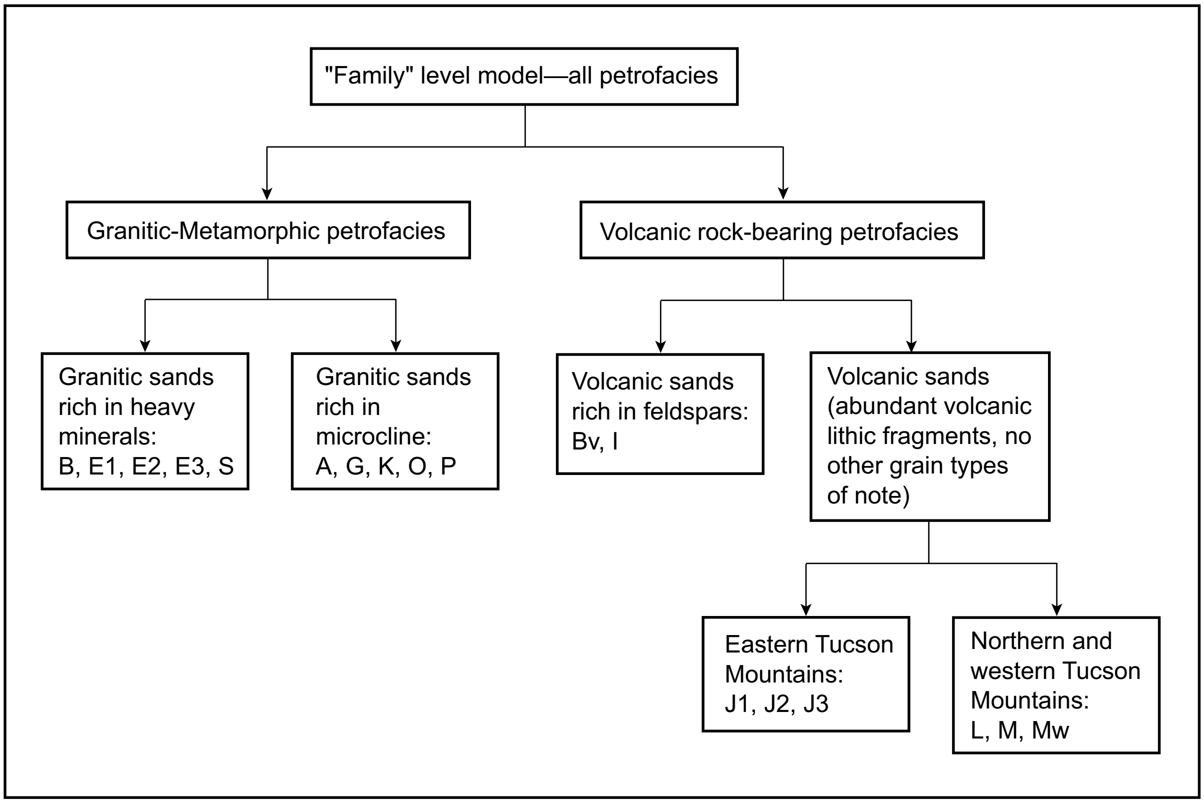

Figure 6.11. Schematic diagram illustrating the relationships among the nested discriminant models in the Tucson Basin Petrofacies model.

Mountain or Sierrita petrofacies. The discriminant analysis also assigned 16 of the sherds to one of these two petrofacies, although the petrographer's assignment does not necessarily match the discriminant analysis assignment in any given case. These sherds have been assigned to the final group "Black Mountain or Sierrita petrofacies." There is considerable compositional gradation in this group between the two petrofacies, and it is difficult to assign them to one petrofacies or another. This may be a case in which the application of sand point-count data to the provenance characterization of sandy pedogenic clay is less exact than preferred. It may also reflect use of the resources in a gradational boundary zone between the two petrofacies (see the case study discussion below). To further complicate the situation, the Black Mountain Petrofacies was not adequately sampled and described at the time of the sherd characterization, so Heidke was unable to identify the sherds to specific petrofacies. Since that time, Heidke has learned to recognize the specific grain combination that characterizes the Black Mountain Petrofacies and to distinguish it from the Sierrita Petrofacies (Heidke and Miksa 2006).

The sherd that was not assigned to either the Black Mountain or Sierrita petrofacies by the discriminant analysis model merits a specific note. Sample RNA-45 was assigned to the Twin Hills Petrofacies by the discriminant analysis model. This sample has a higher than usual proportion of a microgranite that is generally found in the Black Mountain Petrofacies. The microgranite is counted on the LVH parameter (see Table 6.2), but is not the same as the spherulitic hypabyssal volcanic found in the Twin Hills Petrofacies, which is also counted on the LVH parameter. Although this type of overlap rarely causes problems, in this case, it led to a faulty discriminant analysis characterization.

Four sherds characterized by the ceramicist as belonging to the "Mixed Volcanic and Granitic" generic group with an unspecified petrofacies were characterized as belonging to the Black Mountain Petrofacies by the petrographers. Three of the four were classified as Black Mountain Petrofacies by the discriminant analysis; the fourth was assigned to the Airport Petrofacies. The volcanic grains in the four samples are consistent with the mixture of volcanic lithic fragments seen on the western side of the Santa Cruz River near the Black Mountain Petrofacies, not with those seen on the eastern side of the Santa Cruz River in the Airport Petrofacies. The final assignment for the four sherds is the Black Mountain Petrofacies.

Table 6.8. Discriminant analysis results and petrofacies characterizations for the point-counted sherds.

Sample Number	Ceramic Type	Ceramicist's Generic Temper Source	Ceramicist's Petrofacies	Petrographer's Petrofacies	Discriminant Analysis Predicted Petrofacies	Final Petrofacies Assignment
RNA2-01	Indeterminate red	Unspecified	Unspecified	Rincon	Rincon	Rincon
RNA2-02	Indeterminate red	Unspecified	Unspecified	Beehive	Catalina Volcanic	Indeterminate
RNA2-03	Indeterminate red	Unspecified	Unspecified	Extrabasinal	Airport	Extrabasinal
RNA2-04	Unspecified plain ware	Volcanic	Beehive	Beehive	Golden Gate	Beehive
RNA2-05	Indeterminate red	Granitic and mixed lithic	Santa Cruz River	Black Hills	Santa Rita	Airport
RNA2-06	Indeterminate red	Granitic and mixed lithic	Santa Cruz River	Beehive	Airport	Airport
RNA2-07	Unspecified plain ware	Granitic and mixed lithic	Santa Cruz River	Beehive	Airport	Airport
RNA2-08	Indeterminate red	Granitic and mixed lithic	Santa Cruz River	Beehive	Santa Rita	Airport
RNA2-09	Indeterminate red	Granitic and mixed lithic	Santa Cruz River	Beehive	Airport	Airport
RNA2-10	Indeterminate red	Granitic and mixed lithic	Santa Cruz River	Black Hills	Airport	Airport
RNA2-11	Indeterminate red	Granitic and mixed lithic	Santa Cruz River	Beehive	Airport	Airport
RNA2-12	Indeterminate red	Granitic and mixed lithic	Santa Cruz River	Beehive	Airport	Airport
RNA2-13	Indeterminate red	Volcanic	Unspecified	Beehive	Golden Gate	Beehive
RNA2-14	Indeterminate red	Volcanic	Unspecified	Beehive	Beehive	Beehive
RNA2-15	Indeterminate red	Volcanic	Unspecified	Beehive	Beehive	Beehive
RNA2-16	Indeterminate red	Volcanic	Unspecified	Beehive	Beehive	Beehive
RNA2-17	Sobaipuri Plain (folded rim)	Volcanic	Beehive	Beehive	Beehive	Beehive
RNA2-18	Unspecified plain ware	Volcanic	Beehive	Beehive	Beehive	Beehive
RNA2-19	Unspecified plain ware	Volcanic	Beehive	Beehive	Golden Gate	Beehive
RNA2-20	Unspecified plain ware	Volcanic	Beehive	Beehive	Beehive	Beehive
RNA2-21	Papago Plain	Unspecified	Unspecified	Granitic	Airport	Indeterminate
RNA2-22	Papago Red	Granitic	Unspecified	Black Hills	Sierrita	Black Hills or Sierrita
RNA2-23	Papago Red	Granitic	Unspecified	Black Hills	Twin Hills	Black Hills or Sierrita
RNA2-24	Indeterminate red	Granitic and mixed lithic	Santa Cruz River	Beehive	Beehive	Airport
RNA-39	Sobaipuri Plain (folded rim)	Unspecified	Unspecified	Black Hills	Black Hills	Black Hills
RNA-40	Unspecified plain ware	Volcanic	Beehive	Beehive	Beehive	Beehive
RNA-41	Sobaipuri Plain (folded rim)	Volcanic	Beehive	Black Hills	Black Hills	Beehive
RNA-42	Unspecified plain ware	Volcanic	Twin Hills	Twin Hills	Twin Hills	Twin Hills

Table 6.8. Continued.

Sample Number	Ceramic Type	Ceramicist's Generic Temper Source	Ceramicist's Petrofacies	Petrographer's Petrofacies	Discriminant Analysis Predicted Petrofacies	Final Petrofacies Assignment
RNA-43	Unspecified plain ware	Volcanic	Twin Hills	Twin Hills	Twin Hills	Twin Hills
RNA-44	Papago Red	Granitic	Unspecified	Black Hills	Black Hills	Black Hills or Sierrita
RNA-45	Papago Plain	Granitic	Unspecified	Black Hills	Black Hills	Black Hills or Sierrita
RNA-46	Unspecified plain ware	Mixed volcanic and granitic	Unspecified	Black Hills	Airport	Black Hills
RNA-47	Indeterminate red	Mixed volcanic and granitic	Unspecified	Black Hills	Black Hills	Black Hills
RNA-48	Unspecified plain ware	Mixed volcanic and granitic	Unspecified	Black Hills	Black Hills	Black Hills
RNA-49	Sobaipuri Plain (folded rim)	Granitic and mixed lithic	Unspecified	Sierrita	Airport	Airport
RNA-50	Unspecified plain ware	Granitic and mixed lithic	Unspecified	Santa Rita	Santa Rita	Airport
RNA-51	Sobaipuri Plain (folded rim)	Unspecified	Unspecified	Black Hills	Black Hills	Black Hills
RNA-52	Sobaipuri Plain (folded rim)	Volcanic	Unspecified	Beehive	Beehive	Beehive
RNA-53	Unspecified plain ware	Volcanic	Unspecified	Beehive	Beehive	Beehive
RNA-54	Indeterminate red	Volcanic	Beehive	Beehive	Beehive	Beehive
RNA-55	Sobaipuri Plain (folded rim)	Volcanic	Beehive	Beehive	Beehive	Beehive
RNA-56	Unspecified plain ware	Volcanic	Beehive	Beehive	Beehive	Beehive
RNA-57	Indeterminate red	Mixed volcanic and granitic	Unspecified	Black Hills	Black Hills	Black Hills
RNA-58	Papago Plain	Granitic	Unspecified	Sierrita	Sierrita	Black Hills or Sierrita
RNA-59	Papago Red	Granitic	Unspecified	Sierrita	Black Hills	Black Hills or Sierrita
RNA-60	Papago Red	Granitic	Unspecified	Sierrita	Black Hills	Black Hills or Sierrita
RNA-61	Papago Plain	Granitic	Unspecified	Sierrita	Sierrita	Black Hills or Sierrita
RNA-62	Papago Plain	Granitic	Unspecified	Sierrita	Black Hills	Black Hills or Sierrita
RNA-63	Papago Red	Granitic	Unspecified	Sierrita	Black Hills	Black Hills or Sierrita
RNA-64	Papago Plain	Granitic	Unspecified	Sierrita	Sierrita	Black Hills or Sierrita
RNA-65	Papago Red	Granitic	Unspecified	Sierrita	Sierrita	Black Hills or Sierrita
RNA-66	Papago Plain	Granitic	Unspecified	Sierrita	Sierrita	Black Hills or Sierrita
RNA-67	Papago Plain	Granitic	Unspecified	Sierrita	Sierrita	Black Hills or Sierrita
RNA-68	Papago Red	Granitic	Unspecified	Sierrita	Sierrita	Black Hills or Sierrita
RNA-69	Papago Plain	Granitic	Unspecified	Sierrita	Sierrita	Black Hills or Sierrita
RNA-70	Papago Plain	Granitic	Unspecified	Sierrita	Sierrita	Black Hills or Sierrita

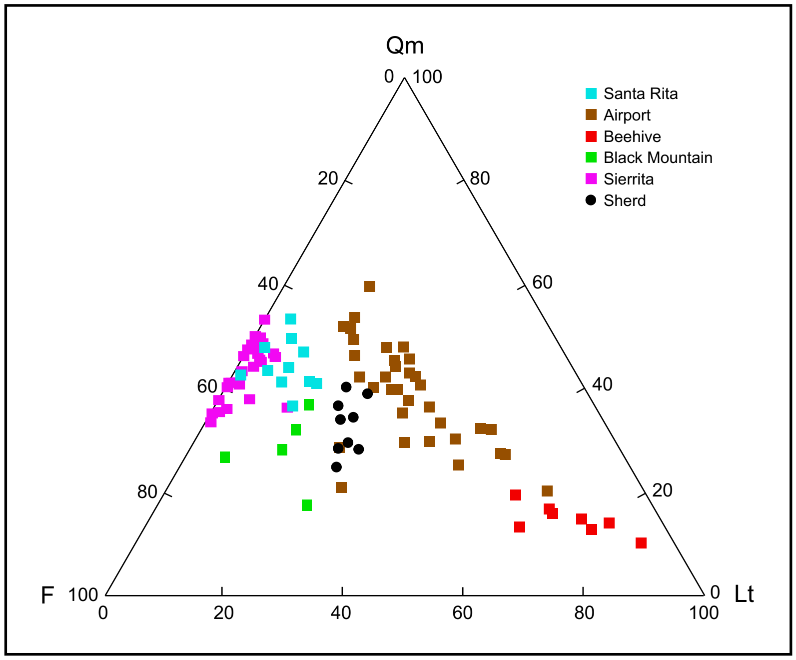

Figure 6.12. QmFLt ternary plot showing sherds assigned to the Airport Petrofacies, along with sand from the Airport, Beehive, Black Mountain, Santa Rita, and Sierrita petrofacies.

Two sherds were characterized by the ceramicist as belonging to the "Granitic Plus Mixed Lithic" generic group with an unspecified petrofacies. One was characterized as the Sierrita Petrofacies by the petrographers, while the other was characterized as belonging to the Santa Rita Petrofacies. In the discriminant analysis model, the first was characterized as belonging to the Airport Petrofacies, while the second was characterized as belonging to the Santa Rita Petrofacies. On petrographic review, both samples were assigned to the Airport Petrofacies; however, this is a provisional assignment. Additional information is necessary to assess the compositional range of both petrofacies, especially the distal ends near the Santa Cruz River.

Nine samples were characterized by the ceramicist as belonging to the "Granitic Plus Mixed Lithic" generic group and the Santa Cruz River Petrofacies. These samples were characterized by the petrographers as belonging to the Beehive and Black Mountain petrofacies. The discriminant analysis classification for six of the samples is the Airport Petrofacies. Two samples are classified as members of the Santa Rita Petrofacies. One sample was classified as a member of the Beehive Petrofacies, although it lacks the distinctive volcanic grains of that petrofacies. Extensive petrographic review shows that the initial characterization by both the ceramicist and the petrographers was incorrect.[1] A QmFLt ternary plot of the composition shows that the temper composition of the sherds overlaps with the composition of Airport Petrofacies sands, but not with those of the Santa Rita Petrofacies (Figure 6.12). Volcanic lithic fragments in the sherds are consistent with those of Airport Petrofacies sands. Therefore, the final assignment of these sherds is to the Airport Petrofacies. With recent improvements in the description of the Airport Petrofacies, and improved characterizations to help distinguish between Airport and Santa Cruz River petrofacies sands in hand-sample, it should be possible to make this distinction more easily in the future.

Six samples were assigned by the ceramicist to the volcanic generic group, with petrofacies unspecified. These samples were characterized by the petrographers as Beehive Petrofacies. The discriminant analysis classification for five of the samples is the Beehive Petrofacies, while the sixth is to the Golden Gate Petrofacies. Petrographic review of the samples suggests all six belong to the Beehive Petrofacies.

Ten samples were assigned by the ceramicist to the volcanic generic group and the Beehive Petrofacies. Nine of the 10 sherds were characterized as Beehive Petrofacies by the petrographers and the discriminant analysis model; the tenth was characterized as Black Mountain Petrofacies by the petrographers and the discriminant analysis model. After petrographic review, all 10 samples were assigned to the Beehive Petrofacies.

Two samples were assigned by the ceramicist to the volcanic generic group and the Twin Hills Petrofacies. Both samples were also assigned to the Twin Hills Petrofacies by the petrographers and the discriminant analysis model. The final assignment of Twin Hills Petrofacies is accepted for these samples.

Discussion

The data presented above show that sands or sandy clays from four petrofacies were used to manufacture the Native American ceramics recovered from the sites investigated during the Rio Nuevo Archaeology project. These four petrofacies include the following.

[1]The Airport Petrofacies composition had not been defined at the time Heidke characterized the temper provenance of these sherds.

- The Beehive Petrofacies, which is south-southwest of the Rio Nuevo sites. It is known as a pottery production area since at least A.D. 350. The Beehive Petrofacies is approximately 4 km from the project area sites, so it is not considered a local production source for the sites.
- The Airport Petrofacies, which covers much of the Tucson Basin floor. The Clearwater site is situated just across the Santa Cruz River from the northwestern tip of the Airport Petrofacies; therefore, it is a local source of sand for the site. The Tucson Presidio is located within the Airport Petrofacies.
- The Black Mountain Petrofacies is located approximately 11 km south of the project area sites; it is not a local production source.
- The Sierrita Petrofacies, located approximately 13 km south of the project area sites is not a local production source.

Combining the final characterization data given above and in Table 6.8 with the proportion of the ceramics represented by the thin-sectioned sherds, 49 percent of the sherds are in a petrographically verified group assigned to a petrofacies. Forty-five percent of the study set remains in petrographically verified groups not assigned to a petrofacies. Approximately 5 percent of the sherds in the detailed study set were not included in the petrographic verification study.

Examination of Table 6.9 shows that source areas are not distributed equally between the sites. For instance, the San Agustín Mission locus has a much larger proportion of sherds identified as originating in the Beehive or Twin Hills petrofacies than the Tucson Presidio, while the Tucson Presidio has a slight majority of the sherds originating in the Black Mountain or Sierrita petrofacies, although the difference is not as pronounced as that for the volcanic petrofacies. The time differences between these two sites may play a role in this difference: The San Agustín Mission locus dates to the Spanish period, A.D. 1694 to 1821, with most of the excavated features dating between 1771 and 1821. The Tucson Presidio dates slightly later, to both the Spanish and Mexican periods, circa A.D. 1775 to 1856. Without additional data and time periods, it is difficult to assess the nature of this pattern. Fortunately, several other sites in the downtown Tucson area have been excavated in recent years and petrographically verified data sets spanning the historic time periods from the Spanish to American Statehood periods are available. A small case study using selected, well-dated features from the Rio Nuevo project sites and other nearby sites has been used to evaluate the relationship among pottery production location, pottery technology, and time in the historic Tucson Basin.

CASE STUDY: THE EFFECTS OF HISTORIC EVENTS ON O'ODHAM POTTERY PRODUCTION IN HISTORIC TUCSON, ARIZONA

In the Historic era, Native Americans in the Tucson area produced ceramic vessels for their own use, as well as for sale or trade to the growing Euro-American community. As noted above, historic ceramics were commonly tempered with sand, sand plus grog, or manure. The pottery production locations and technology of manufacture changed through time. This study explores these changes.

Native American pottery from eight sites and site components in the Tucson area, excavated by Desert Archaeology, Inc., over the last 10 years (Figures 6.13-6.14; Table 6.10) was examined. The sites were occupied throughout the Historic era, from approximately A.D. 1771 to 1929; that is, from the time of Spanish occupation, through the Mexican period, and into the American Territorial and American Statehood periods. The sites are located along the eastern and southern flanks of the Tucson Mountains.

To explore changes in production technology and provenance over time, a collection of 1,097 decorated sherds and plain ware rim sherds from well-dated contexts spanning 12 distinct time intervals at the eight sites was selected for detailed ceramic analysis (Figure 6.15; Table 6.11). The contexts are dated by historic artifact content, and it is these dates that have been applied to the ceramics.

As noted above, information such as ceramic form, style, vessel size, and detailed notes on decorative elements was recorded for each sherd. Additionally, temper attributes were identified by the project ceramicist, so that the sherds could be compared with known sand temper sources available in Tucson. A random sample stratified by ware and temper characterization was used to select 67 of the sherds for thin sectioning so that detailed petrographic analyses could be completed. Overall, a 6.1 percent sample was thin sectioned, although this sample is not distributed evenly through all sampled time intervals (see Figure 6.15). The sherds were point counted and submitted for discriminant analysis, as detailed above.

Results

Results of the discriminant analysis were very strong. Most of the pottery can be assigned to petrofacies found near the central and southern Tucson Mountains. Much of it was produced in the Beehive Petrofacies, a known production area since prehistoric times. Limited numbers of sherds with Twin Hills Petrofacies sands were recovered. This is also a

Table 6.9. Number of sherds and proportion of thin sections in each final provenance group.

					Number of Sherds (proportion of sherds) in the Detailed Ceramic Analysis Set, by Site[b]		
Generic Temper Source[a]	Specific Temper Source[a]	Final Temper Characterization	Total Sherds Not Characterized to Petrofacies	Total Sherds Characterized to Petrofacies	BB:13:13	BB:13:481	BB:13:6
Unspecified	Unspecified	Unspecified	666		82 (0.03)	13 (0.01)	571 (0.024)
Granitic	Unspecified	Black Mountain or Sierrita petrofacies	–	288	171 (0.07)	0 (0.00)	117 (0.005)
Mixed volcanic and granitic	Unspecified	Black Mountain Petrofacies	–	42	39 (0.02)	0 (0.00)	3 (0.001)
Granitic and mixed lithic	Santa Cruz River	Airport Petrofacies	–	239	0 (0.00)	0 (0.00)	239 (0.001)
Granitic and mixed lithic	Unspecified	Airport Petrofacies	-	26	25 (0.01)	0 (0.00)	1 (0.000)
Volcanic	Unspecified	Unspecified	407	–	17 (0.01)	0 (0.00)	390 (0.016)
Volcanic	Beehive	Beehive Petrofacies	–	268	50 (0.02)	0 (0.00)	218 (0.009)
Volcanic	Twin Hills	Twin Hills Petrofacies	–	308	12 (0.01)	0 (0.00)	296 (0.012)
Column totals			1,073	1,171	396 (0.17)	13 (0.01)	1,835 (0.077)

Notes: Total sherds in the study set:	2,373
Total sherds in a petrographically verified group:	2,244
Percentage of total study set in a petrographically verified petrofacies:	*49.3*
Percentage of total study set not in a petrographically verified petrofacies:	*45.2*
Percentage of total study set not petrographically verified:	*5.4*

[a]From ceramicist's temper characterization.
[b]All site numbers are AZ # (ASM).

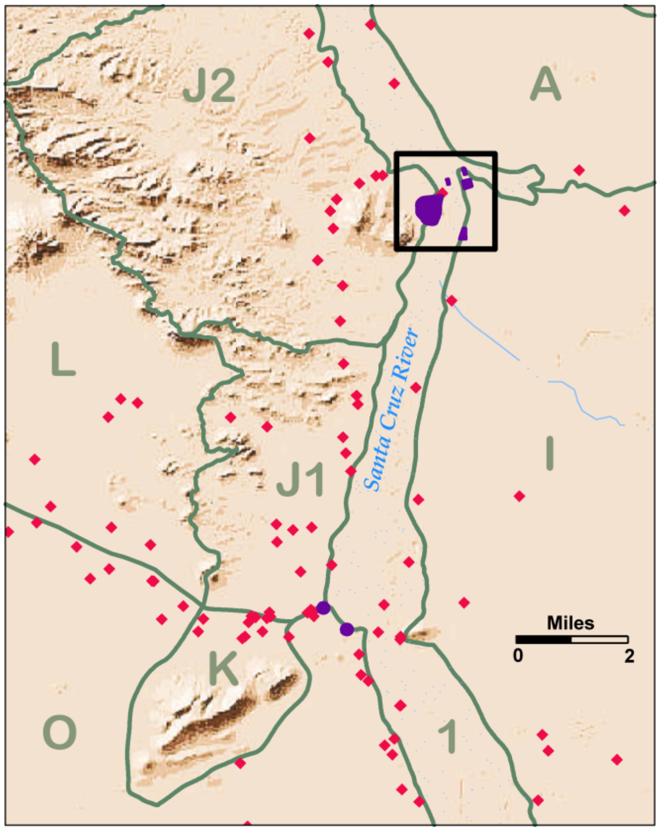

Figure 6.13. Overview of archaeological sites in the case study, showing nearby petrofacies.

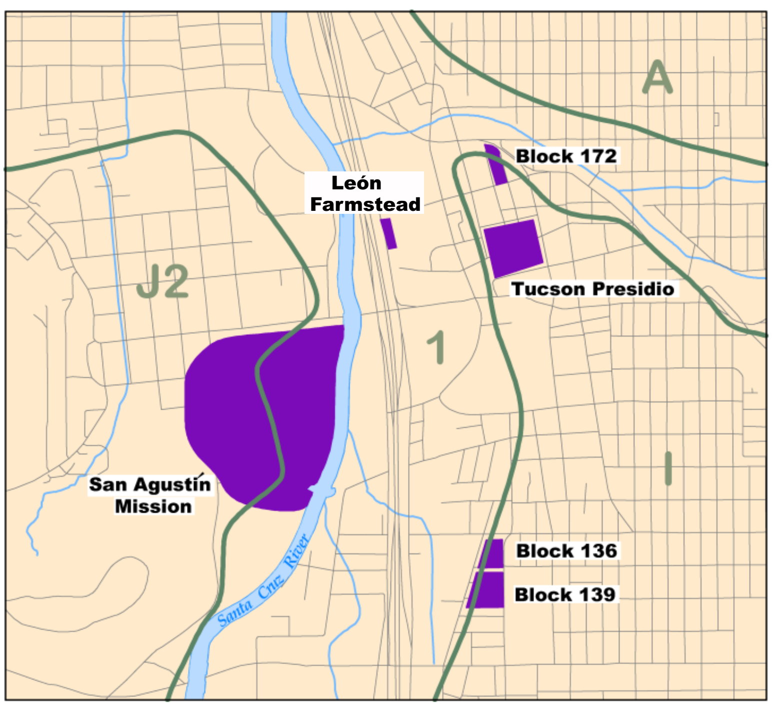

Figure 6.14. Close-up of archaeological sites in the case study, showing site names and locations in downtown Tucson.

known prehistoric production area. Interestingly, a large number of pots produced in the Airport Petrofacies were recovered. Finally, a majority of the pottery recovered from these sites was manufactured in the Black Mountain Petrofacies, or in either the Black Mountain or Sierrita petrofacies. This latter group is a set of ceramics that grades in composition from one petrofacies to the other. The two petrofacies are adjacent and closely related, and their boundary is a diffuse geomorphic transition zone on the bajada of the Sierrita Mountains, with alluvial tributaries moving freely back and forth across the landscape. Much of the pottery was likely produced along the boundary zone between the two petrofacies, near San Xavier del Bac Mission. Two historic villages are noted in a late nineteenth century map of the San Xavier area; they straddle this boundary zone (Chillson 1888). The potters may have lived in or near these villages.

The temper type analysis confirms long-held notions about the change from sand or sand plus grog temper to fiber temper over time (Figure 6.16). Almost all the ceramics recovered from the San Agustín Mission locus, from features dating between 1771 and 1821, are tempered with sand or sand plus grog, as are the ceramics recovered from features at the Tucson Presidio dating from 1810 to 1820. In the ceramics recovered from units dating to the 1820s and 1830s at the Tucson Presidio, fiber temper begins to appear, but other temper types are also used. In the next time interval, 1840-1869, fiber temper jumps to more than 50 percent of the total pottery recovered from the León farmstead, AZ BB:13:505 (ASM). By the 1870s, fiber-tempered pottery comprises the majority of that recovered from all of the sites. By 1890, it is the only temper being used in Native American pottery.

The trends in temper composition reflect those seen in temper type (Figure 6.17). In the earliest San Agustín Mission deposits, the pottery was being produced primarily in the Beehive and Airport petrofacies. The Airport Petrofacies source is local to those sites and to Tucson at the time. The Beehive Petrofacies source is 4 km to the south. There is a very small amount of pottery from the Twin Hills Petrofacies, which is local to the sites. Starting in the early 1820s, the Black Mountain and Sierrita petrofacies

Table 6.10. Sites and site components used in the case study.

Site Number	Site Name	Feature	Date Range	Historic Period
AZ BB:13:6 (ASM)	San Agustín Mission	64, 161, 166, 177, 178, 193, 203	1771-1821	Spanish
AZ BB:13:13 (ASM)	Tucson Presidio	373	1810s-1820s	Spanish to Mexican
AZ BB:13:13 (ASM)	Tucson Presidio	409, 441	1820s-1830s	Mexican
AZ BB:13:505 (ASM)	León Farmstead	4 (Stratum 50.03), 14, 25, 28	1840-1869	Mexican and American Territorial
AZ BB:13:6 (ASM)	Carrillo Household	61	1860-1880	American Territorial
AZ BB:13:505 (ASM)	León Farmstead	4 (Stratum 50.02)	1870-1880	American Territorial
AZ BB:13:13 (ASM)	Block 181	376	Late 1870s-early 1890s	American Territorial
AZ BB:13:505 (ASM)	León Farmstead	4 (Stratum 50.01)	1880-1890	American Territorial
AZ BB:13:644 (ASM)	Block 139	19	1890-1895	American Territorial
AZ BB:13:668 (ASM)	Block 172	46, 54	1891/1892-1900	American Territorial
AZ BB:13:513 (ASM)	Block 136	60	1898-1911	American Territorial and American Statehood
AZ BB:13:513 (ASM)	Block 136	7, 41	1916-1929	American Territorial and American Statehood

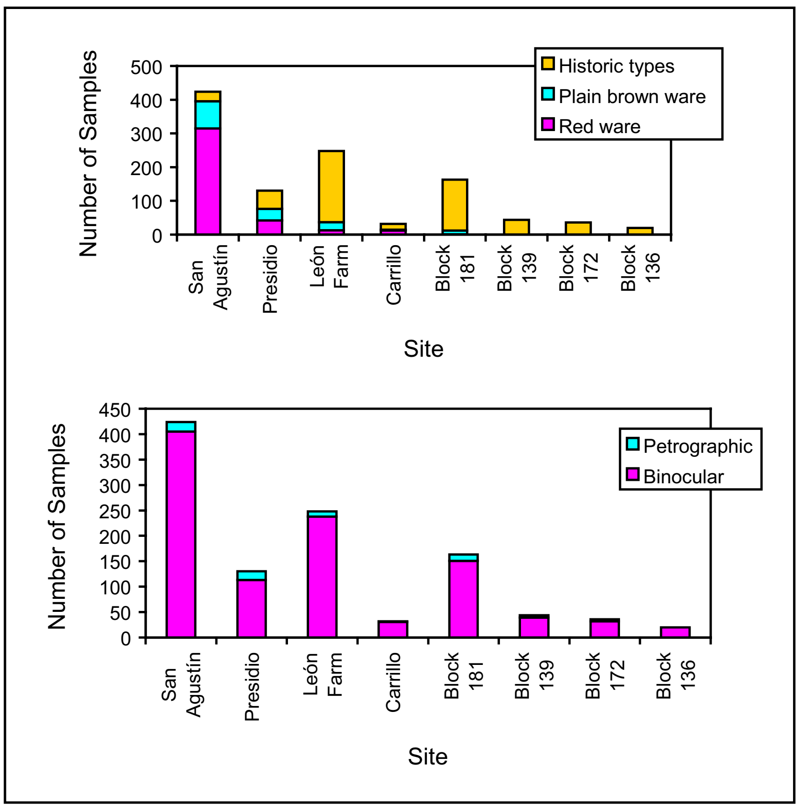

Figure 6.15. Distribution of ceramic sample, by ware, site, and analytical group.

begin to be used, and apparent production falls off at the Beehive Petrofacies. Clearly, the Native American population was still free to use materials located in a wide area around Tucson. This changed, however, as the century progressed. In the 1840 to 1869 time interval, there was a dramatic increase in pottery produced in the Black Mountain/Sierrita petrofacies, concomitant with the change to fiber temper. By the 1870s, the Black Mountain/Sierrita petrofacies composition dominates the assemblage, and its proportion increases through time.

These changes in ceramic technology and provenance coincide with the major political events of the Historic era. The Spanish claimed Arizona soon after their *entrada* into the "New World," although there was not a strong Spanish presence near Tucson until Father Kino founded missions at Guevavi (1692) and San Xavier del Bac (1699). The San Agustín Mission, a *visita* of San Xavier, was founded in 1757 at the Native American village of "*Schook-shon*," followed by the Tucson Presidio in 1776. Throughout this time, the Spanish exercised political control over the Tucson area, until Mexico established independence in 1821. Interestingly, although the San Xavier Mission was well established prior to 1800, it is not until the second decade of the nineteenth century that Black Mountain/Sierrita

Table 6.11. Number of sherds in the case study, by ware, site, time interval, and type of analysis.

Site[a]	1771-1821	1810s-1820s	1820s-1830s	1840-1869	1860-1880	1870-1880	Late 1870s-Early 1890s	1880-1890	1890-1895	1891/1892-1900	1898-1911	1916-1929	Row Total
	Time Interval												
Total Sherds Analyzed													
Red Ware													
BB:13:006	315	0	0	0	12	0	0	0	0	0	0	0	327
BB:13:013	0	18	24	0	0	0	1	0	0	0	0	0	43
BB:13:505	0	0	0	13	0	0	0	0	0	0	0	0	13
BB:13:513	0	0	0	0	0	0	0	0	0	0	0	0	0
BB:13:644	0	0	0	0	0	0	0	0	0	0	0	0	0
BB:13:668	0	0	0	0	0	0	0	0	0	0	0	0	0
Column total	315	18	24	13	12	0	1	0	0	0	0	0	383
Plain Brown Ware													
BB:13:006	80	0	0	0	3	0	0	0	0	0	0	0	83
BB:13:013	0	9	25	0	0	0	11	0	0	0	0	0	45
BB:13:505	0	0	0	16	0	1	0	7	0	0	0	0	24
BB:13:513	0	0	0	0	0	0	0	0	0	0	0	0	0
BB:13:644	0	0	0	0	0	0	0	0	0	0	0	0	0
BB:13:668	0	0	0	0	0	0	0	0	0	0	0	0	0
Column total	80	9	25	16	3	1	11	7	0	0	0	0	152
Historic Types													
BB:13:006	29	0	0	0	17	0	0	0	0	0	0	0	46
BB:13:013	0	10	44	0	0	0	151	0	0	0	0	0	205
BB:13:505	0	0	0	66	0	14	0	131	0	0	0	0	211
BB:13:513	0	0	0	0	0	0	0	0	0	0	15	5	20
BB:13:644	0	0	0	0	0	0	0	0	44	0	0	0	44
BB:13:668	0	0	0	0	0	0	0	0	0	36	0	0	36
Column total	29	10	44	66	17	14	151	131	44	36	15	5	562
Thin-sectioned Sherds													
Red Ware													
BB:13:006	14	0	0	0	0	0	0	0	0	0	0	0	14
BB:13:013	0	1	2	0	0	0	0	0	0	0	0	0	3
BB:13:505	0	0	0	0	0	0	0	0	0	0	0	0	0
BB:13:644	0	0	0	0	0	0	0	0	0	0	0	0	0
BB:13:668	0	0	0	0	0	0	0	0	0	0	0	0	0
Column total	14	1	2	0	0	0	0	0	0	0	0	0	17
Plain Brown Ware													
BB:13:006	4	0	0	0	0	0	0	0	0	0	0	0	4
BB:13:013	0	1	4	0	0	0	1	0	0	0	0	0	6
BB:13:505	0	0	0	3	0	0	0	0	0	0	0	0	3
BB:13:644	0	0	0	0	0	0	0	0	0	0	0	0	0
BB:13:668	0	0	0	0	0	0	0	0	0	0	0	0	0
Column total	4	1	4	3	0	0	1	0	0	0	0	0	13
Historic Types													
BB:13:006	1	0	0	0	1	0	0	0	0	0	0	0	2
BB:13:013	0	4	5	0	0	0	11	0	0	0	0	0	20
BB:13:505	0	0	0	2	0	1	0	4	0	0	0	0	7
BB:13:644	0	0	0	0	0	0	0	0	5	0	0	0	5
BB:13:668	0	0	0	0	0	0	0	0	0	4	0	0	4
Column total	1	4	5	2	1	1	11	4	5	4	0	0	38

[a]All sites are AZ # (ASM).

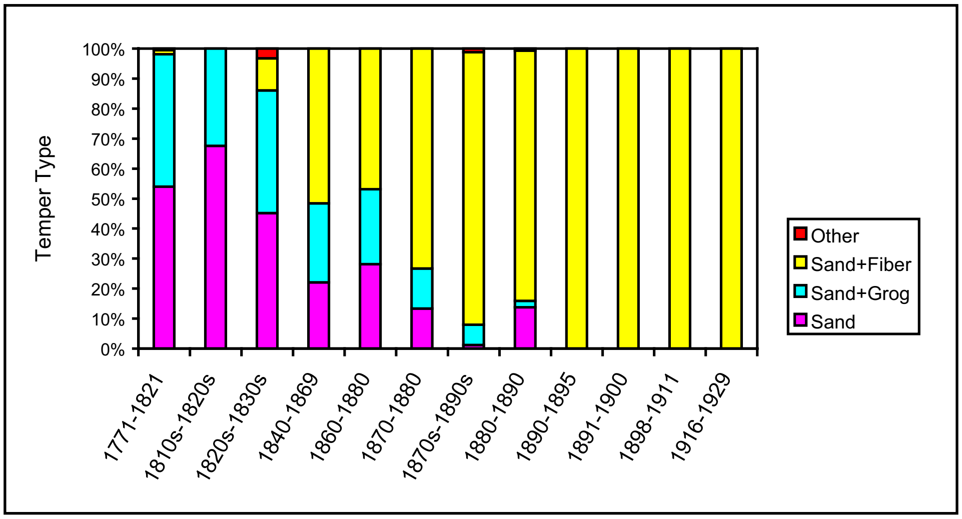

Figure 6.16. Bar chart showing results of the temper type analysis through time.

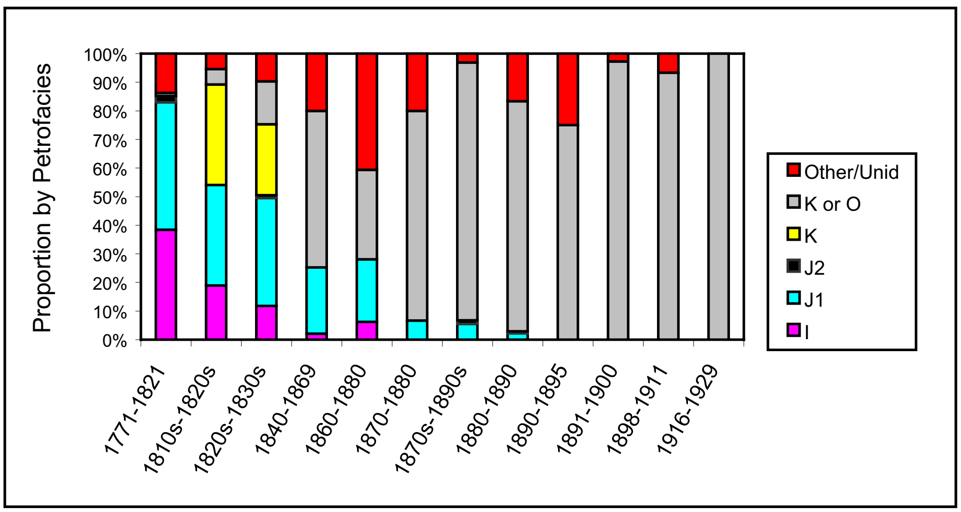

Figure 6.17. Bar chart showing results of the temper composition analysis through time.

petrofacies temper begins to appear in the archaeological record. Many factors contributed to this pattern: an influx of non-Native American peoples, Apache raiding, disease among the O'odham, and huge regional economic changes all occurred at the same time. Without evidence from contemporary sites located near the San Xavier Mission, it is difficult to know if pottery production had occurred in that area and was simply not traded to Tucson, or if pottery was not produced in the area prior to the mid-nineteenth century.

The most significant changes in pottery production occur in the decades following Mexican independence. In the period between 1840 and 1870, the shift to fiber-tempered pottery from the Black Mountain/Sierrita petrofacies occurs rapidly, as this pottery begins to represent 50 percent of the assemblage or more. The influx of Euro-Americans and Mexicans to the Tucson area may have limited the availability of source materials in central Tucson, while the O'odham were simultaneously being "encouraged" to live near the San Xavier Mission. This population shift was intensified after the Gadsden Purchase of 1853, making Tucson and southern Arizona a part of the United States and bringing American political control to the region. The United States government established the San Xavier Reservation for the Tohono O'odham in 1874. At that time, over 80 percent of the pottery recovered from the archaeological deposits discussed here came from the Black Mountain/Sierrita petrofacies, near the reservation boundary and San Xavier Mission.

While interpretation of the temper provenance record is straightforward with respect to the historic record in this case, interpretation of the temper type record is more difficult. What brought about the shift from sand or grog temper to fiber temper? The idea of using manure as temper may have been imported with the influx of people into the area in the nineteenth century. The O'odham potters probably lost political control of land in the Beehive Petrofacies, formerly a preferred pottery production area. The material properties of the pedologic clays in the Black Mountain/Sierrita petrofacies could have required a more plastic temper than sand or grog. Alternatively, it could be that the O'odham potters needed a temper that was less expensive in terms of labor. As horses and cattle increased in the region, so did a readily available, free, preprocessed temper source. Fontana (personal communication 2005) reports that it was just "easier" to make pots with manure temper rather than sand, and ease of production may have become an increasingly important factor as the O'odham supplied not only themselves, but a growing Euro-American population with water storage jars and everyday cookware (Naranjo 2002). The fiber-tempered pottery may have also been lighter and easier to transport.

In summary, the historic pattern of pottery production and distribution in the Tucson area is clear. In the approximately 200 or so years that saw the coming of the Spanish, Mexicans, and Americans to the region, pottery production shifted from a pattern much like the prehistoric, to one that was governed by the new political and economic realities of the times.

CONCLUSIONS

This technical study addresses two areas of interest. The first is the composition and provenance analysis of 56 thin sections for the Rio Nuevo Archaeology project, representing 2,373 sherds examined for the detailed ceramic analysis. Temper type assessments made by the ceramicist and the petrographers were found to be in agreement in all but one case. Temper composition and provenance assessments were in agreement on previously known and well-defined petrofacies. This project has helped refine current understanding of temper composition and provenance for two major sources that were previously inadequately defined. A group of sherds with granitic and mixed lithic sand was shown to have probably originated in the Airport Petrofacies, a large area occupying much of the floor of the Tucson Basin. A group of sherds with granitic sands, a distinctive altered granite or granodiorite, and distinctive Tucson Mountain volcanics was shown to have originated in the Black Mountain or Sierrita petrofacies, near the San Xavier Mission.

The second subject addressed in this study is that of placing the Rio Nuevo data in a wider regional and temporal context by combining data from Rio Nuevo sherds with that from several recently excavated nearby sites. The combined data set allowed us to study pottery production and distribution in the Tucson-San Xavier Mission area from circa A.D. 1771 to 1936. The data from the case study show a change in O'odham pottery production over time. In the earlier part of the study interval, pottery was sand tempered, or sand plus grog tempered, and was produced in the Beehive or Airport petrofacies. By the middle of the study interval, pottery production began shifting southward, near San Xavier Mission, and grog temper was replaced by fiber temper. By the end of the study interval, nearly all pottery was tempered with fiber and was produced in the Black Mountain or Sierrita petrofacies, probably near the San Xavier Mission. In this context, data gained from the Rio Nuevo excavations are integral in developing an understanding of the broad patterns of Tucson's history.

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