# Late Prehispanic and Hispanic Ceramics in the Purén, Lumaco, and Liucura Valleys, *La Araucania*, Chile

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Editor

Vanderbilt University Publications in Anthropology

Number 53

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Vanderbilt University Publications in Anthropology, Number 53

2010

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**Acknowledgements**

We wish to thank the numerous Mapuche friends, colleagues, and families who facilitated our research in the Purén and Lumaco Valley, as well as the Chilean families, especially Mr. Benjamin Davis who provided us with access to their lands in the Liucura Valley. Very special thanks are extended to the Mapuche communities in the Purén and Lumaco Valley who not only granted us the permission to work on their lands but also work alongside us as we surveyed and excavated sites. We are grateful to them for tolerating our presence and for sharing their indigenous knowledge with us.

Several institutions also warrant recognition: the Corporación Nacional de Desarollo Indigéna and the Consejo de Monumentos Nacionales for granting work permits to carry out the archeology; the Universidad Austral de Chile and the Universidad Católica de Temuco, where I hold professorships, for providing logistical and academic support, and the National Science Foundation, the Guggenheim Foundation, the National Geographic Society, the University of Kentucky and Vanderbilt University for giving financial support.

Many colleagues, friends and students are thanked for working in the field with us. The list is far too long to thank all of them here, but special recognition goes to Arturo Rojas, René San Martin, José Manuel Zavala, José Saávedra, Oscar Seguel, and several others for forming part of the research team. Our gratitude also is extended to Carlos Ocampo who is a good friend and colleague; he has served as the Chilean counterpart to the Purén-Lumaco Project.

We are grateful to Paige Silcox for drafting the illustrations. Thanks are extended to Patricia J. Netherly for copyediting.

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**Chapter 1**

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*Introduction*

This monograph presents the cultural implications derived from study of Prehispanic to Hispanic (~AD 500-1750) pottery from 376 surface-collected and excavated sites in the Purén and Lumaco Valley and 29 similarly studied sites in the Liucura Valley of the Araucania region of south-central Chile (Figure 1.1). (The people of the Araucania were named the Reche by the Spanish of the 16th century and have been known as the Mapuche since the mid-18th century.) Several questions underlying current research on the region are addressed, with the primary goal of shedding new light on pottery classification, chronology, and distribution patterns during the Early Prehispanic and Late Prehispanic (~AD 500-1550; hereafter EPH and LPH, respectively) to Early Hispanic (~AD 1550-1700; EH) periods. Traditionally, studies of Araucanian pottery have concentrated primarily on the analysis of relative chronology, decorative design, and elements of vessel shape (Adán and Mera 1997; Adán and Alvarado 1999; Aldunate 1989; Berdichewsky and Calvo 1973; Bullock 1955; Dillehay 1981, 1990 a,b; Garcia 2008; Gordon 1975, 1978, 1983, 1984, 1992; Gordon et al. 1973; Hayduk 1978, 1984; Latcham 1928 a, b; Mera et al. 2004; Menghin 1962; Navarro and Adán 1999; Ocampo et al. 2004; Quiroz 1997, 2001, 2008; Quiroz and Sánchez 1997, 2005; Quiroz et al. 1997; Reves et al. 2003-2004; Sánchez 1997; Sánchez et al. 1981-1982; Valdés et al. 1982). However, the present study also focuses on these topics and additionally seeks to provide objective evidence to determine whether or not production and distribution patterns indicate local and non-local manufacture. Pottery can be an indicator of resettlement, migration, and/or co-residency of different groups. It can also indicate the sharing of preferences for style and technology, and patterns of indigenous rejection, if not resistance, to the Spanish intrusion of the 16th and 17th centuries (see Dillehay 2007).

Two Araucanian populations existed during the study period. The northern Araucanians lived north of the Bío Bío River in central Chile. They were defeated first by the Inca and later by the Spanish during the 15th and 16th centuries, respectively. The southern Araucanians resided south of the Río Bío Bío, were not defeated by the Inca. The Spanish occasionally penetrated during the 16th and 17th centuries. They were conquered by Chilean armies at the end of the 19th century (Bengoa 2003). Depending upon their location along the Pacific coast, in the central valley, or in the Andes, the southern Araucanians were fishermen, sedentary agriculturalists, or hunters and gatherers. Today, the Mapuche live in isolated settlements and reservations in south-central Chile where they still fish, grow staple crops such as maize, wheat, and fruits, and raise sheep, cows, fish, collect piñon nuts, and engage in the modern market society (Bengoa 1985, 2003; Bocarra 2007; Dillehay 1990a, 2002, 2007). Early Spanish chronicles note that many Araucanians of the 16th and 17th centuries lived in geographically-separated kin groups with little or no centralized authority, but were generally subject to local or kin-based chiefs (*ulmen*, *lonko*), except in times of conflict when war chiefs (*toqui*) would unite disparate neighboring groups to fight outsiders (Quiroga 1979; Rosales 1989). During the Hispanic period, some Araucanians were more centralized, as numerous war chiefs came together to form larger *ayllarehue* and *butanmapu* political organizations designed to unite kin and non-kin groups and resist the Spanish and

Chilean governments (Ercilla y Zuñiga [1569] 1982; Bocarra 1999; Dillehay 1976, 1981, 1990a, 2007; León 1990; Padden 1993; Zavala 2000).


Figure 1.1. Location of study areas.

The Araucanians are probably best known as one of the few indigenous ethnic groups in the Americas that successfully resisted European colonization and maintained cultural and social autonomy for over 350 years with minimal change to their traditional social and religious organization (Bengoa 2003; Boccara 1999; Dillehay 2007; K. Jones 1999; Padden 1993). Crucial to understanding the historic cultural complexity and resistance of the Araucanians was the struggle by chiefly lineage-agents to impose a higher, more centralized level of political and economic order and a new social organization for politically strategic ends against intruding outsiders (Bengoa 2003; Boccara 1999; Dillehay 2002, 2007). This was especially the case of the "*Estado*", as the chronicler Ercilla called it, which was a politically organized area made up of several large indigenous populations (e.g., Catiray, Arauco, Pai Cavi, Tucapel, Purén-Lumaco: Figure 1.2), located immediately south of the Río Bío Bío and along the western and eastern flanks of the Nahuelbuta coastal range. Resistance to the Spanish was fiercest in this area.

The early development and resistance of the Araucanian polity was related to the tactical, structural, and organizational power (*sensu* Wolf 1999) of chiefly agents who drastically and rapidly reorganized the parts of the indigenous society at a higher socio-political level (1) by recruiting population sectors fragmented by warfare with the Spanish and by incorporating them through public feasting ceremonies at large-scale ceremonial places (e.g., *rehuekuel*), (2) by geographical expansion of chiefly lineages by means of the annexation of neighboring territories, and (3) by ceremonial feasting for alliance building. These strategies increased the size of chiefly lineages, provided them with larger warrior groups and support populations, solidified their internal coherence, expanded their geo-political reach, and strengthened their political confederations even more (Dillehay 2007). Although they were able to successfully resist European influences from ~AD 1550 to 1890, Araucanian society also experienced an unstable socio-political milieu as lineages united to defeat the Spanish. As a result of this prolonged struggle, the Purén and Lumaco Valley was one area where the Araucanians united to become the central force of resistance from ~AD 1550 to 1650. Both internal unification and fragmentation of the Purén-Lumaco population resulted from warfare and lineage displacement, migration, and recruitment of distant groups to sustain a viable defense system. Not all of these transformations occurred evenly in the Araucanian territory or everywhere but rather only in strategic locations, which were favorable to geo-political defense, sustainable population nucleation, and intensive agricultural production, and where local lineages successfully resisted outsiders.

To summarize, this monograph provides documentation of demographic, exchange, and socio-political patterns of a particular Araucanian polity by presenting analyses of archeological ceramics recovered from numerous sites studied by the Purén and Lumaco Valley project. Specifically discussed are ceramic type description and patterning, chronological information, Instrumental Neutron Activation Analysis (INAA), and petrographic analysis of ceramics from excavated and surface-collected sites. The petrographic study was performed by Dr. Mario Pino of the Universidad Austral de Chile, Valdivia. The INAA study was conducted by Drs. Leslie Cecil and Michael Glascock of the University of Missouri. Similar research objectives and analyses were applied to fewer sites in the Liucura Valley where early mound complexes and Spanish artifacts also are found.

This is the second monograph in a series of studies focused on the ethnohistory, archeology, and ethnography of the Purén and Lumaco Valleys and the Liucura Valley. The first study was centered on registry and description of the archeological sites in both valleys and briefly discussed their broader implications to regional archeology and culture history. Later volumes will present more detailed studies on the archeological excavations at mound (*kuel*) and domestic sites and more detailed ethnohistorical, paleoecological, and other specialty studies.

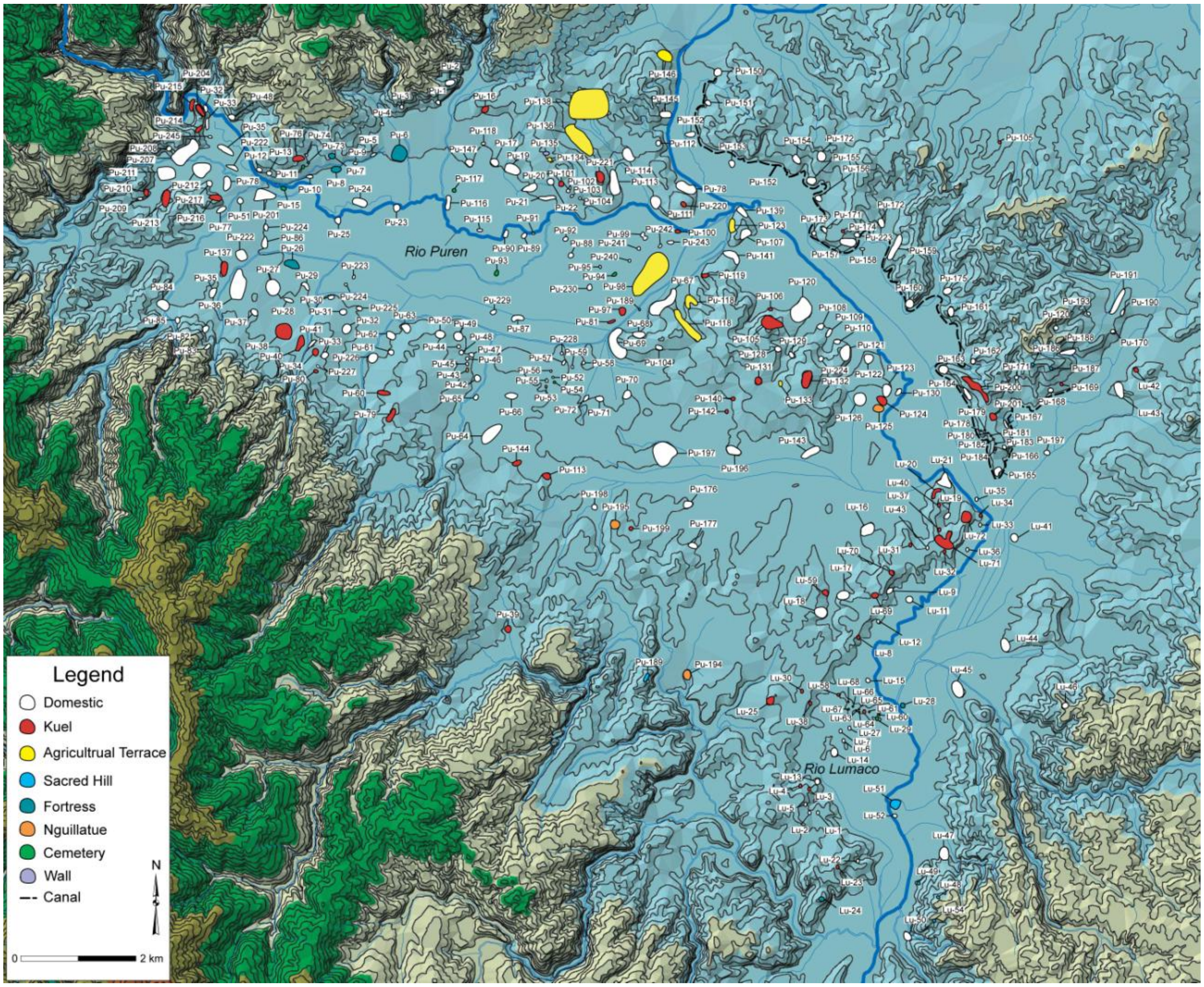



Figure 2.2. Map of all sites in the Purén and Lumaco Valley.

This monograph is organized into six chapters. The introductory chapter presents the research objectives and methods. Chapter 2 is given to the analytical approaches. Chapter 3 defines the pottery types and discusses their spatial distribution in the study area. Chapter 4 presents the INAA and petrographic analyses. Chapters 5 and 6 discuss interpretative spatial and temporal trends, respectively, for ceramic attributes. Chapter 7 concludes the ceramic findings.

*Research Area, Questions, and General Approach*

The forested south-central region of Chile is comprised of two mountain ranges, the Andes to the east and the coastal Nahuelbuta range to the west. Lying between the two ranges is the central valley. The research reported here is located in the Purén and Lumaco Valley, located on the west side of the central valley in the eastern range of Nahuelbuta. The Liucura Valley is situated on the western flanks of the Andean mountains in the Lake District of southern Chile, approximately 25 km from the international frontier between Chile and Argentina. The late historic to contemporary environment of these two small, circumscribed valleys is temperate forest, lakes and fertile wetlands. The Purén and Lumaco Valley is characterized by extensive seasonal wetlands; the Liucura Valley drains to the west into the Lago Villarrica, a large pre-cordillera lake.

Although the Purén and Lumaco Valley refers to two river drainages, it is actually a single river that has its headwaters in the Nahuelbuta Range to the west, where the Purén River descends. Approximately 25 km downstream the Purén River turns to the south where the name changes to Lumaco. In referring to the entire study area, we use the term Purén and Lumaco Valley. In reference to the specific Purén or west and east branch of the entire river, we call it the Purén River or valley. The same is applied to the Lumaco River or Valley.

The Purén-Lumaco Project addressed two specific questions: 1) the ways in which processes of recruitment, annexation, and ceremonial feasting were employed and structured to expand chiefly authority and to sustain long-term resistance to the Spanish, and how these processes are reflected in the archaeological record, specifically the ceramic registry is presented in this study; and (2) how chiefly authority produced by regulating ceremony at mound complexes. These questions were designed to directly test the early historical record by archeological study of the material cultural patterning (e.g., sites, ceramics) of these processes (Dillehay 2007). A specific archeological aim was to identify the settlement location of historically referenced fragmented, recruited, and incorporated lineages by locating, identifying, and dating non-local ceramics (and other artifacts) in domestic sites of the Purén and Lumaco Valley. The reverse process also was studied by locating Purén and Lumaco sherds in annexed domestic sites of historically referenced areas outside of the valley (e.g., Angol, Chol Chol, Repocura).

The historical documents describe periodic warfare, mound-building associated with the burial of important war chiefs, and the occasional recruitment and annexation of neighboring lineages just prior to and during prolonged contact with the Spanish. These practices intensified in the late 1500s, especially in the Arauco, Catiray, Pai Cavi, Tucapel, and Purén and Lumaco areas of the *Estado*, the center of resistance to the Spanish (e.g., Ercilla y Zuñiga [1569] 1982; Rosales [1674] 1989; Bengoa 1995, 2003; Dillehay 2007). We know that leaders in other areas of the Araucanian region held ideological, economic, and military power similar to those in these areas, but lived in places that usually never became centers of prolonged political resistance or never developed large-scale ceremonial mound complexes and extensive agricultural villages) like those in the Purén and Lumaco Valley and, to a lesser extent, the Liucura Valley (Dillehay 1985, 2007). The presence of these cultural attributes suggests that venues of power other than ideology, military, and economy were important, such as the tactical and organizational skills of war time leaders of the *Estado*.

One hundred percent archeological survey coverage of the ~30 km long Purén and Lumaco Valley was carried out between 1985 and 2004 (Dillehay 1995, 2007). This work recorded more than 300 prehistoric and historic localities, including residential sites, agricultural features, fortresses, cemeteries, and mound complexes of different scales (Dillehay and Sáavedra 2010). Settlement information demonstrates occupation primarily in the LPH and EH periods (AD 1200-1750), with a light scatter of Archaic and EPH period sites (pre-AD 1200). Previous research in the study areas focused on incipient complexity in Prehispanic times, which was related to the adoption of cultigens, settlement nucleation, and social ranking in the rich, circumscribed setting of the valley (Dillehay 2007). This research recorded a shift from small, isolated burial mounds in the 12th to 14th centuries AD to large clusters of multi-functional mounds (i.e., ceremonial, administrative, and burial) in the 15th and 18th centuries AD. The appearance of settlement nucleation and large-scale mound complexes are clear archeological indicators of a semi-centralized to centralized political system emerging between AD 1450 and 1500 and fully developing between AD 1550 and 1700. These large-scale complexes either do not occur in other valleys in south-central Chile, or they are present in dispersed and low densities, indicating small, scattered communities with less cultural development and political centralization (Dillehay 1995, 1999, 2007).

Based on the combined historical and archeological records, we know that large and continuous demographic changes were taking place among most Araucanian populations during the EH period, especially those in the Tucapel, Arauco, Purén, and Catiray areas. The archeological evidence indicates EH population surges in these areas which coincided with historically documented decreases in other areas (Dillehay 2007: Dillehay and Sáavedra 2010). That is, population surges chracterized by an increase in archeological sites in the Purén and Lumaco Valley during the EH period suggest that as areas along the Bío-Bío frontier and farther south in the central valley were resettled or depopulated, as a result of conflict, the Purén and Lumaco Valleys (and other areas) might have received displaced emigrants. We can hypothesize that some of these populations emigrated to the valley, which would have led to an increase in the material inventory and variability of the archeological record (i.e., ceramics). Although the ethnohistorical and archeological evidence for the Liucura Valley is much more limited, it suggests that similar processes were occurring there.

In sum, we have learned from the written documents that chiefly leaders during the EH period, with their intensive and escalating monopolies of recruitment and feasting, were the products of the centralizing effect of increased conflict in a previously non-centralized confederation of loosely linked lineages. The archeology indicates an explosive mound and domestic site build-up in the late 16th to early 17th centuries AD, heavy population fragmentation and displacement in the 17th to 18th centuries, and the development of complex chiefdoms in areas of resistance to the Spanish. Both the historical and archeological records suggest a developed leadership structure and a controlled subsistence economy that was of a markedly different organizational order from that found in the 14th through middle 15th centuries AD. A prestige economy and wealth in surplus goods were not achieved until the late-18th century when long-distance raiding and marauding began in Argentina and north of the Río Bío Bío River (e.g., Mandrini 1992).

There is also evidence from the historical and archeological records of a chain of developmental events starting with the initial appearance of small mounds and agricultural sites in the late EPH to late LPH period to large-scale mound building and agricultural villages extending from the EH period to the turn of the 19th century AD. This is not just an issue of economic fragmentation, a centralization of political power in ceremonial centers, and an accompanying increase in both cooperation for defense and competition for recruitment and annexation of other indigenous groups. Rather, it was a marked *reorganizational shift* in the Araucanian population of the Purén and Lumaco Valley and other areas that was orchestrated by confederated lineages producing new spaces for the exercise of chiefly agency, which was constantly negotiated and ritually enacted to bring about a higher order of social cohesion and resistance to the Spanish. Set in this context, this ceramic study and the patterns inferred from it are focused on these research issues and historical processes.

*Ceramic Approaches to Recruitment and Annexation*

Recruitment and annexation are two different processes of lineage expansion that should have different archeological and ceramic patterning. Recruitment of outside groups may be represented by the presence of non-local ceramics at Purén-Lumaco sites. Annexation of neighboring lands may be expressed by the presence of Purén-Lumaco wares and small mound complexes at sites within them. In lineage areas of the Purén and Lumaco Valley, historically known to have recruited outside groups, domestic sites should be characterized by a higher variability of ceramic decorative and manufacturing styles that represent multiple lineages from different places. Annexed lands should also reflect more ceramic variability, specifically an admixture of local and Purén-Lumaco styles.

Further, we suspect from comments available in the written records and from ethnoarcheological studies of emigrants today that adopted groups were (and still are) consistently situated in the southeast sector of lineage lands and seated in the southeast space of ceremonial fields (Not known is the extent to which this pattern was practiced across the Araucania.) To date, we have identified two domestic sites (PU-27 and PU-36) and one ceremonial site (PU-38) near the present-day town of Purén, which have a spatial concentration of exotic sherds in their southeast sectors and possibly are associated with the recruitment and adoption of outside groups. Annexation of neighboring lands involved the reverse, whereby people from the Purén and Lumaco Valley moved into incorporated lands.There is no information to suggest the cardinal placement of the sector they occupied in these lands. We have located two sites mentioned in Repocura (an area located about 35 km south of the Purén and Lumaco Valley) as either having been inhabited by people or in-married women from the Purén and Lumaco Valley. The sherds (n=8 and 11, respectively) are polished redwares with muscovite and quartz tempers typical of the latter area and not found in the Repocura area. The sherds were randomly scattered over the surfaces of sites.

These processes were tested in the ceramic record through the application of models of settlement/community patterning and ceramic formal variation, particularly those focusing on seriation and chronological markers of change, style and technological choice, and their temporal and spatial distributions. In addition to the ceramic analysis, we also carried out extensive settlement pattern and excavation analyses at several sites (Dillehay and Sáavedra 2010). As a result, we have established a preliminary $C^{14}$ and TL-dated ceramic typology and site typology (e.g., site size, mounds, defensive and agricultural features, domestic areas, stratigraphy, proximity to natural resources) and linked some archeological sites to events and named localities in the written texts (Dillehay 2007). However, much more work needs to be done in this area of study before more conclusive interpretations can be offered. This is one of the goals of this monograph.

Our research has also indicated continuous occupation of some domestic sites and discontinuous or multiple, ephemeral occupations of others during the 16$^{th}$ and 17$^{th}$ centuries. Several of the latter sites are associated with a few diagnostic Spanish goods and LPH/EH Araucanian ceramics with European inclusions (e.g., glazed ceramics, glass temper, glass beads), suggesting that occupational disruption might be related to a sporadic Spanish presence or influence. Many domestic sites also exhibit continuous and relatively thick deposits (~30-80 cm) containing a sequence of LPH (pre-AD 1550), Valdivia polychrome (an Inca-influenced style (?) roughly dating between AD 1500-1700), Spanish (AD 1550-1810), and Chilean Republic (>AD 1810) ceramics. Also documented are a wide variety of local and probably non-local ceramic wares from several domestic sites, as determined by surface treatment, temper, decoration, vessel form, and petrographic and INAA analyses, all of which suggests the co-residence of local and limited non-local population sectors resettled by outside groups. Co-residency might reflect recruitment of non-local groups fragmented by conflict elsewhere with the Spanish. The ceramic research also was crucial to interrelating sites within the Purén and Lumaco Valley, constructing a local developmental sequence via artifact analysis, clay source studies, and absolute TL dating to establish the affinity and chronology of sites. Although most Araucanian decorative styles and vessel forms are similar in *kuel* and domestic sites, different technological styles have been detected at the local-level and are useful for determining affinity and local community boundaries associated with different areas of the valley.

*Chronological Scheme*

Araucanian pottery has not, traditionally, been studied as a whole. Instead, excavated ceramic assemblages have been divided into different decorative or chronological groups and published separately in various articles, such as those for the early Pitrén negative resist wares and the later El Vergel and Valdivia polychrome styles, monochrome or plainware pottery (Adán and Mera 1997; Aldunate 1989; Dillehay 1981; Menghin 1962; Ocampo et al. 2004), and historic and contemporary ceramics (Garcia 2008).

Previously defined and radiocarbon dated ceramic types, Pitrén, El Vergel, Valdivia, and Spanish glazed wares, were the basis for the ceramic chronology employed in the study areas. In Malleco Province where the Purén and Lumaco Valley is located, the archeology of areas outside of Angol, Purén, and Lumaco is poorly understood. Earlier work in the region by Bullock (1955), Berdichewsky and Calvo (1973), Navarro and Adán (1999), Quiroz and Sánchez (2005), Sánchez (1997), among others have identified El Vergel and other Prehispanic wares, but they have not been published extensively. Recently, Quiroz (2010) presented 48 TL-dated contexts at several sites along the coast south of the Bío Bío River and on the Isla Mocha and Isla Santa María. The Quiroz chronology places the Pitrén style between about AD 400 and 1100 and the El Vergel style between AD 600 and 1500 but mainly between AD 1000 and 1500. Although El Vergel might be too early in his sequence and his TL dates require confirmation from stratified radiocarbon dated contexts, there is general agreement his sequence and the one presented in this study. Farther south, other studies have described and dated Pitrén and other wares (e.g., Adán and Mera 1997; Adán and Alvarado 1999; Berdichewsky and Calvo 1973; Gordon 1984: c.f., Gaeta and Sánchez 1995; Donoso 2010; Correa 2010; Berón 2010), but the style of ceramics in these studies are closely related to those in our study area and thus are reliable cultural markers for this analysis. Several ceramic studies in close proximity to the Liucura Valley are useful for cross-comparative purposes (Adán and Mera 1997; Adán and Alvarado 1999; Berdichewsky and Calvo 1973; Gordon 1992; Sáavedra and Sanzana 1989).

While long-term manufacture of Pitrén wares has been acknowledged, in the Purén and Lumaco Valley their presence decreased dramatically during the LPH period, especially in contrast to the later El Vergel style. While many of the Purén and Lumaco sites assigned to the LPH on the basis of surface-collected ceramics undoubtedly had subsequent EH occupations, and vice-versa, the use of El Vergel as a precise temporal diagnostic is problematic for several reasons. First, because it is a poorly dated ceramic style, it is difficult to estimate its short- or long-term use at sites. Second, it perhaps inflates the number and extent of LPH occupations, because slipped El Vergel sherds were also recovered from C14 dated EH deposits at several excavated sites in the study area, which also contained sherds with Spanish attributes (e.g., glazed wares, glass, inlaid porcelain crosses on the necks of jars). Third, it also inflates the number of LPH occupations because it was often the only diagnostic type found at sites. In other words, the necessary reliance placed on the El Vergel style as a cultural and temporal marker compounded the problem of site assignments, because we did not have the benefit of a larger sample of radiocarbon dated rims and bases of non-diagnostic wares. The presence of additional dated wares would have allowed more temporally and culturally specific assignments. Exceptions are the Valdivia, Spanish, and later Chilean wares (i.e., mixed European styles), which often influenced the decorative and manufacturing styles of some Purén and Lumaco ceramics (e.g., clay type, temper, slips, smudging, texturing, smoothing, polishing). This sometimes resulted in hybrid styles. Either pure or hybrid styles are highly diagnostic, but rare, and have been employed to date EH sites fairly accurately. There are also a few sherds that seemingly had decorative attributes of both the El Vergel and Valdivia styles, which overlap chronologically during at least the AD 1500 to 1600 period (c.f., Bahamondes 2010). If a larger sample of Valdivia sherds had been recovered from the Purén-Lumaco project, it might indicate that the two styles shared certain territories during the Spanish contact period, if not earlier. Most of the ceramics (~85 percent) from both study areas in this analysis date to the LPH period. Many types of this period extend into the EH period, which probably constitutes ~5-7 percent of the total collection. The remaining portion roughly belongs to the EPH period.

Based on these considerations, the ELH, LPH, and EH periods are defined on the basis of radiocarbon and TL dates obtained from several sites (see Dillehay 2007), but primarily the type site PU-165 where extensive excavations were conducted and the largest ceramic assemblage recovered (Appendix I), as well as similarities in the frequencies and attributes of the ceramic assemblage. Based on the current data, we suggest that the EPH for the Purén and Lumaco Valley dates from ~AD 400 to 1100; the LPH ranges from ~AD 1100 to 1550; and the EH spans ~AD 1550 to 1750. Some future subdivision of these periods may be warranted, along with the adjustment of the boundaries between them. However, the Pitrén, El Vergel, Valdivia, and early Hispanic ceramics from most sites in the valley are generally similar to and date about the same time as those recovered from other site areas in south-central Chile (e.g., Huimpil, Calafquen, Valdivia). More accurate results are required from compositional studies of a larger ceramic sample from surveyed and excavated sites in order to more precisely define the areal affinity and age of ceramic types and to better identify source areas of emigrated and annexed groups.

The chronological scheme for the Liucura Valley is much weaker than it is for the Purén and Lumaco Valley and currently is based upon a few radiocarbon and TL dates and comparative analysis between local and non-local ceramic styles.

*Epilogue*

Future publication will present more specific intra-site and intersite analyses of the ceramic assemable, especially with regard to the excavated sites and *kuel* mounds. Those studies also will report on other clay objects receovered from excavations and surface sites, including daub, untempered clay balls, and pipe fragments. Also presented will be the sedimentolgy studies of Mario Pino and Oscar Seguel, which located raw clay deposits used not only for ceramic vessels but also for the floors and fills of the *kuel* mounds. Given the significance of the clay study to mound construction and inter- and inter-valley locational analyses, these data will be reported in publications specifically focused on the results of site excavations.

## Chapter 2: The Purén and Lumaco Ceramic Assemblage: Methods and Approaches

Tom D. Dillehay

*Introduction*

The ceramic assemblage from Purén and Lumaco sites was collected through survey and stratigraphic excavation, from contexts including *kuel* mound floors and fills, domestic use surfaces, house floors, hearths and middens, and a few fortresses and cemeteries. A total of 17 *kuel* and domestic sites were excavated or tested during the course of the Purén- Lumaco Project. Three sites were tested in the Liucura Valley. Block excavations (*bloques*) were carried out at sites PU-52, PU-122, PU-132, PU-165, PU-220, PU-221, LU-69, and LU-71 in the Purén and Lumaco Valley. The most extensively excavated site was PU-165, a large and deep domestic site located at the conjunction of the Purén and Lumaco streams. This site dated from ~7,000 to 350 years ago and yielded the vast majority of surface and excavated sherds. Several block excavations (e.g., *Bloques* A-D) and test pits (e.g., *Pozos* 1-10) were placed in this site. Since PU-165 produced the largest quantity and widest variety of ceramics and the most $C^{14}$ dates, which collectively represent the entire ceramic and occupational history of the valley, it was used to establish the ceramic type collection for this study. The second largest ceramic collections were retrieved from sites PU-122 and PU-157.

All test pits and block units in all sites were excavated in arbitrary 15 cm levels except for areas where clear house floors and use surfaces were present, and these were treated as separate stratigraphic layers. The nomenclature shown in ceramic profile drawings, tables, and other figures depict these units and levels for PU-165 and other sites. A future publication will present all excavated artifactual and paleoecological data.

In total, 13,519 sherds from broken ceramic vessels were analyzed, 13,081 of which exhibited measurable characteristics recorded as attributes. Only one whole vessel was encountered in the research, a small necked jar with short, everted rim (*cantaro*), although several complete vessels recovered by local residents were examined. The assemblage is dominated by plainwares or serving wares, most often with a narrow range of surface techniques and rim and lip forms. Lesser quantities of polished red and orange slipped serving wares of the El Vergel of the LPH period and later styles of the EH period are present, and sometimes incised, as well as polychrome Valdivia sherds decorated in black, red, and white (e.g., Menghin 1962). The lack of good archeological visibility at most sites in the forested and heavily vegetated environment of south-central Chile and the laboratory methods used to examine recovered ceramics required the collection of all diagnostic and most non-diagnostic artifacts encountered on the surface of sites.

To facilitate the recovery of materials during hand excavation, all deposits were screened through 1.0 and 0.5 cm mesh. Small (portable) hand-held screens were used during shovel-testing, larger framed screens were used during excavations so that higher volumes of soil could be processed. Ceramics removed from hundreds of flotation samples also were included in the analysis. In the laboratory, each bag of materials was washed using soft brushes and water and allowed to dry before being returned to a tag-labeled bag. After being washed, all ceramics were entered into a general artifact/bag log, along with a basic description of that bag's contents (e.g., ceramics, lithics).

Within the conceptual perspective given in Chapter 1, the Purén and Lumaco assemblage was studied with the following specific goals in mind: 1) to ascertain the technological and compositional variability of pottery, its fabrics, and types of manufacture from the Purén and Lumaco Valley; 2) to identify compositional groups and their probable sources; and 3) to attempt to determine whether any non-local pottery represents trade, merely a more general inter-regional shared style and technology, or the movement of recruited outside groups to the valley.

The ceramic assemblage, representing materials recovered from more than 300 archeological sites, was assigned to 15 ceramic types and four varieties. The majority of the vessel forms from Purén and Lumaco are jars or pitchers (*jarros, cantaros, metawe*) and cooking kettles (ollas, *challa*), with a few sherds representing small cups (n=9, *taza*), plates (n=11, *plato*, *rale*), and bottles (n=3, *botella*). Handles are intermediate loop straps aad thick straps usually located on the upper shoulder. A few handles (n=9) are bifurcated and nodes are connected to the top of some handles. Drinking cups have looped handles running from the lip to the upper wall of the vessel or midway between the lip and the middle wall. Temporal and spatial trends within these data are analyzed below. Several aspects of the ceramic analysis are multifaceted and, to a certain extent, skewed by the type of data retrieved by the project. For instance, most of the data relate to technological continuity of many attributes and to an emphasis on paste, temper, and surface treatment rather than decoration, the latter of which is poorly represented in the collection except for a limited number of red and orange slip wares of the El Vergel style, late incised specimens, and a few painted Valdivia sherds of the terminal LPH to EH period.

As mentioned above, there are a few varieties of new or hybrid ceramic types established in the study area during the EH period, probably resulting primarily from demographic shifts due to warfare and to the mixture of populations across many areas. It is beginning to appear that the EH period became a catchall designation for many ceramic materials, especially if hybrid forms were found in higher numbers when compared to the more spatially extensive and previously known El Vergel and incised wares.

Lastly, as noted earlier, the majority of the ceramics were recovered from PU-165. This site alone yielded 75.7 percent of the entire sherd collection from its surface and subsurface deposits and was dated by multiple stratigraphically excavated radiocarbon and TL dates ranging between ~460 to 2500 years ago BP (Appendix I).

As for the Liucura Valley ceramic assemblage, the same methods were applied, though dating the collection was restricted to a few radiocarbon measurements from subsurface test from three sites. Also, due to thicker vegetation cover in the Liucura Valley, which limited ground visibility, the surface collections from sites was smaller in number than those from localities in the Purén and Lumaco Valley. A total of 521 excavated and surface sherds are in the Liucura collection.

### *Ceramic Paste, Surface Treatment, Form and Motif Attributes*

The organizing principles of the Purén-Lumaco ceramic analysis focus on the attributes that reflect potters' preferences and the clay sources that were available within the region: type of paste, presence or absence of temper, type of temper, size of temper, color, lip, rim and vessel form, and surface modifications. No assumptions were made about the combinations of particular attributes in the ceramic analysis to avoid forcing previously observed attributes into similar known groupings (e.g., Pitrén, El Vergel, and Valdivia types and their varieties). Likewise, a detailed analysis of surface modifications were carried out because decorated ceramics (e.g., incised types, red and orange slips, paint) were used perhaps in certain lineage (i.e., *lof*) or ceremonial contexts, where feasting, recruitment of outside groups, and alliance-building strategies often took place. They were also likely to be instrumental tools that local leaders (e.g., *toqui*, *lonko*, *caciques*, *shamans* or *machi*) used in public events aimed at maintaining their authority and legitimacy, as well as creating solidarity with other and/or lesser elites and non-elites (Dillehay 1995, 2007). Besides documenting the types of surface treatment applied during this analysis, the study also employed a more comprehensive motif analysis that recorded and compared the types of motif elements applied in the decoration of vessels and the combinations of elements. A coding system was incorporated that allowed for the accounting of multiple general and specific surface modification techniques (e.g., paint, slip, glaze, incision, smoothing, impression). Not examined in this study are the production techniques of pottery (e.g., oxidation, firing, kilns, hearths). All ceramics recovered from the study areas were made by coiling, however.

Paste Attributes

Paste attributes considered in this analysis pertain to the presence, type and size of added temper, paste color, and, when determinable, clay or paste type (defined by INAA and petrographic analyses), which is indicative of firing atmosphere as well as desired aesthetic and/or symbolic qualities of vessels. Surface paste color was the primary color used in the assignment of paste classification; however, core color patterns were also recorded, using a Munsell Color Chart. Past and current studies of regional Araucanian ceramics separate pastes into two broad initial categories: those without temper and those with temper (see Chapter 4). Examples of ceramics without temper include fine incised and occasionally slipped wares of the LPH and EH periods and Spanish wares of the EH period. Examples of ceramics with temper are the Pitrén, El Vergel, and many plainware types. Additional subdivisions occur within these two categories, usually on the basis of surface treatment type (e.g., smoothing and/or polishing, incision, red or orange slips), but they can also be defined by temper type. It was assumed that several types would dominate the assemblage, in particular plainwares, but also El Vergel types. However, other types might have been produced during the LPH and EH periods that accounted for minor components in earlier times which could have increased in importance during the later periods. No specific paste types were identified with specific vessel forms.

Tempered ceramic categories were first divided according to temper size: fine, medium, and coarse. These size categories were based on an estimation of the average size of temper particles: fine (<0.2 mm), medium (0.3-0.5 mm), and coarse (>0.5 mm). Use of average grain size, as opposed to maximum grain size, simplified how we dealt with very large (coarse) aberrations (outliers), which were noted on analysis sheets, but not classified separately. Within size categories, additional distinctions were made on the basis of temper type. Historic ceramics were defined according to the presence of certain EH traits (e.g., glaze, porcelain, certain handle and base forms).

Types of temper in the study area usually fall into three basic categories taken from the same rock formation (see thin section study by Pino in Chapter 4): primarily granite (that may also contain some quartz, plagioclase, potasic feldspar, amphibole, biotite, or epidote), schist/phyllite, and syenite. Very infrequently or rarely other tempers, such as volcanic ash, sand, grog and shell, respectively, occur as tempers in pastes. Tempers that often occur naturally in pastes include quartz and feldspar sand particles.

Temper was primarily obtained by crushing granite rocks that are found throughout the study area. Quartz, feldspar, and other minerals erode from the granite formation soils and wash into streams and rivers of the region. Quartz and quartzite pebbles were found throughout most shovel-tested and excavated deposits. The source of exotic tempers such as shell and grog are not known but are likely related to wares brought into the valley by external groups. Sherds with volcanic ash temper likely derived from localities closer to the Andes to the east. All sherds containing exotic tempers are associated with LPH and particularly EH sites.

Paste color can be indicative of the time, temperature, and atmosphere in which vessels or other clay objects were fired. Other factors affecting paste color include the size, amount, and distribution of impurities, in particular iron and organic material, within the raw clay (Rice 1987: 333). Within the study area, paste color, in addition to other attributes such as the presence/absence of temper, is important for distinguishing types, particularly fine paste (untempered) types. Within fine paste ceramics, vessels that were fired under oxidizing conditions are considered distinct from those fired under reducing conditions.

Because the modal variations in Purén-Lumaco ceramic paste colors are relatively unknown due to sampling bias from the lack of a wider variety of excavated sites and of prior ceramic studies for the region, we incorporated broad color categories into the coding system. This allowed much more time to be spent on the examination of other attributes, such as surface motifs, because we did not need to record the hue and chroma for each sherd. Colors included varieties of orange, brown, gray, black, red, orange, and cream. As noted above, a Munsell Soil Color chart was used to document the surface colors. Considerable variability nevertheless existed within each color category.

Surface Modifications

Surface modifications include a variety of techniques used to change the surface properties of vessels. In the Purén and Lumaco Valley, eight categories were distinguished on the basis of general type of execution technique (e.g., polish, smoothing, slip, incision, punctation, paint, impression, glaze). These categories were then subdivided according to color, in the case of slips, paints, and differential firing, or specific mode of execution in all other groups (e.g., fingernail or stick punctation).

Regarding the estimated color of slips and paints in particular, observed colors were recorded. The method is especially pertinent to the colors red, orange, cream, brown to dark brown, and black. Red pigments often take on brown tones during oxidation, if iron minerals were employed. In the instances where a true red could be observed, or where the pigment was preserved as a reddish-brown, then the color red was recorded. However, if brown without reddish tones (usually a chocolate color) was observed, that slip or paint color was recorded as brown, even though that may not have been the originally intended pigment color. This was particularly the case of the few Valdivia painted wares recovered in the valley. By recording observed slip or paint color, we attempted to reduce observed bias in our analysis.

In well preserved ceramics, the discrimination between paints and slips is a fairly uncomplicated task. Unfortunately, most recovered sherds were not well preserved. This is especially the case for painted ceramics. When occasional flecks of pigment are the only evidence that a vessel was decorated, it can be difficult to discern slips from paints. On rare examples (n=2), paint overlies a slip, allowing for more straightforward classification. Or, if pigment appears in zones (e.g., exclusively on the shoulder or neck of vessels), or in remnant motifs, then the paint identification is more secure. The thickness of the lens of the pigment can potentially allow paints and slips to be distinguished, with paints sometimes being more thickly applied, unlike thinner washes or slips. This appears especially true of slipped, painted and incised ceramics of the LPH and especially of the Valdivia wares of the EH. But most paints in the area were slip paints, created by the use of clay of a different color, or the addition of pigment to clay, and they can be thin; moreover, some slips can be thick, such as El Vergel red and orange. Because of the difficulty of distinguishing slips from paints, it would probably be best to combine the separate surface treatment categories into a single "applied pigments" group, except for the well-preserved pigments, but despite some "best guess" determinations, during our analysis we nevertheless attempted to discriminate between the two general categories.

Other surface treatments are less prone to confusion. For descriptions of particular surface modification techniques, the reader is referred to Rice (1987). In our analysis of plastic surface treatment techniques, only a few warrant further comment here. Within the "incision" category of techniques, distinctions are made between coarse and fine incision. While brushing or combing might not typically be considered incision, in order to maintain comparability in the coding system, these texturing categories were included under the umbrella category of "coarse incised" surface treatments. Fine incision was probably executed with the cutting edge of a lithic blade or a thin mussel shell. Fine incision was generally used in the application of simple motif elements, such as lines that sometimes adorned the interior or exterior lips of vessels. Because these decorations required less precision, the width of the drawn lines often is wider than those that characterize fine incision. Line width was not measured, but the techniques are exemplified in figures at the end of Chapter 3. Corrugated surfaces were rarely present at LPH and EH sites. The editing author conducted all motif analysis, ensuring consistency of results.

Decorative Motifs

In the Purén and Lumaco Valley, decorative motifs are seen in incised decoration as well as modeled and a few appliqué elements. This discussion does not include more regular types of surface design such as monochrome or polychrome slips, plastic designs applied to partial or entire vessel surfaces and glazes. Rather, we focus here on identifiable motifs that can be used to evaluate Purén and Lumaco's role in a wider social, religious, and political system.

Plastic surface treatments were often executed in distinct design patterns, or motifs. Motifs are defined as combinations of motif elements. Motif elements are the basic unit of analysis used in this study of decoration. A motif element, according to Rice (1987: 248), is the "smallest self-contained component of a design that is manipulated or moved around as a single unit." We employ this definition of motif elements, as well as Rice's definition of motifs and motif configurations, realizing that it can be difficult to define what constitutes the smallest unit of analysis. Examples of motif elements identified within the assemblage include circular punctation, parallel lines (used as fill), steps, and perpendicular line panel dividers.

Exceptions of motifs that are not divided into constituent elements are those found on Valdivia painted wares. While variability can exist in the particular layout of motif elements, this ceramic type is fairly well established and its different expressions were drawn. Because the entire assemblage of ceramics consists of vessel fragments, the identification of complete motifs and their configurations is problematic. From a purely quantitative perspective, it can be difficult to know whether motif complexity (estimated by the number of constituent motif elements) is the result of greater detail in the overall design pattern or the limited size of broken sherds. However, particular motif elements tend to be more closely associated with more complex motifs than others. Therefore, even though some small sherds may represent only a portion of a larger motif—with only one or two motif elements present on a sherd—we can generally infer from more complete examples that the larger vessel from which that fragment came bore complex motif configurations. There are some motif elements (e.g., single lines) that, if they occurred alone on sherds, we would not be able to ascertain whether they were once part of larger motifs or if they stood alone. Mode of decoration can suggest a more or less complex design (e.g., coarse incision or fine incision), but a few examples were recovered, on which motif elements (e.g., appliqué lentils, punctates) that often occurred in complex motif configurations seemingly were the primary components of simpler designs (see figures at end of Chapter 3). However, if only one motif element was present on a particular ceramic fragment, then it usually represented a comparatively simple design. If two or more elements were present, then the represented motif or motif configuration was probably comparatively complex.

Incised decorations were added to the vessels before firing, when the clay was in the leather-hard stage. These designs were executed using pointed or flat tools such as sticks, antler, bone, sharp stone tools, cane, or shell. In total, 251 sherds with incised designs were analyzed. Only 11 examples had slip and incised designs, and in these cases the incision was executed after the application of the slip in four cases.

Some of the more simple incised designs include parallel lines of circular punctations, horizontal and vertical lines and grooves, curving lines, circles, inverted Vs, pseudo-chevrons, and simple cross-hatching. Geometric designs and the decorative elements of the line break and cleft are significant in that they have been identified as markers for the LPH and EH periods (Gordon 1984; Mera et al. 2004), as well as related traditions from more distant regions of Central Chile (e.g., Falabella and Planella 1982; Falabella et al. 2001; Iribarren 1964; Sánchez and Gaeta 2001; Planella and Stehberg 1994). Incised ceramics in the study area include only a few generally defined geometric designs, double line breaks, and single line breaks (see figures at the end of Chapter 3). A few sherds exhibited appliquéd lentils but these were very infrequent (n=5) in the total collection.

Vessel Form Attributes

The morphological attributes of vessels were recorded for overall basic form, wall shape and orientation, and rims and lips. Basic form, usually assessed from fragmented rim sherds, employs categories estimated on the basis of vessel proportions, usually height to diameter, but also shape. For the general criteria used to distinguish among forms, the reader is referred to Rice (1987). Within the basic form category, we also included non-vessel objects made from fired clay—

daub—for ease of quantification. In the case of vessels, orifice diameter estimations were attempted, though irregularities around the rims of hand-made Araucanian vessels can skew results. Several rim sherds were too small to measure orifice diameter. The profiles for all moderate to large rim sherds were drawn, as shown at the end of Chapter 3. Nearly every ceramic type was characterized by a variety of rim and lip forms, usually slightly everted and straight rims with rounded or tapered lips.

Studies of ceramic vessels have additionally categorized forms, especially when corresponding with particular pastes, into general functional categories, such as service and utilitarian forms. Similar distinctions are made here, but they are not formally classified. For example, neckless jars (*jarro*, *cantaro*, *metawe*), cooking pots (*olla*, *challa*), drinking vessels or cups (*taza*; see rim profiles for cups in Appendix III), and a few late bowls (*escudilla*), bottles (*botella*), and plates (*plato*, *rale*: the latter are an infrequent occurrence in the assemblage of the study area) are thought to represent serving vessels perhaps used in socially charged contexts because their forms are unrestricted (allowing for easy access and display), they are more shallow than tall necked jars and large open-mouth urns (which would have been intended to keep vessel contents in place), and often they are decorated. Necked jars, on the other hand, are often inferred to have utilitarian storage functions, especially large ones, because of their restricted orifices and high storage capacity (volume), especially when they are made from coarse tempered, undecorated pastes. Large necked and a few neckless urns are thought to be associated with human burials.

Similar methods were applied to the Liucura Valley collection which contains vessel forms similar to thoese recovered from the Purén and Lumaco assemblage.

**Chapter 3: Description and Chronology of Ceramic Types**

Tom D. Dillehay, A. Gwynn Henderson, David Pollack, and Paige Silcox

*Introduction*

The ceramic typology used during this study was developed through a modal analysis that recorded attributes of form, surface treatment, surface color, decoration, temper, and paste. This typology generally follows the type-variety system concepts to classify the pottery (e.g., Sabloff and Smith 1969; Smith and Gifford 1965; Smith et al. 1960), with a primary focus on surface treatment, vessel form, and paste attributes. According to this methodology, ceramics are classified into the organizational categories of type and variety. A ceramic type, defined by common attributes of surface treatment and paste, can be considered as roughly equivalent to a ware for ceramic classification (Hatch 1989).

Types are distinctly recognized by specific visual characteristics. Following regional naming guidelines, in this study, new types were given local topographic titles, such as Purén, Lumaco, Trauma, and so forth. Identification of known types also is used (i.e., Pitrén, El Vergel, Valdivia (e.g., Menghin 1962: Dillehay 1990). Varieties are further subdivisions within types, based primarily on surface treatment and secondarily on paste characteristics. They are assigned letters A or B under the formal type. In this study, variations in form and decoration are described, but not given formal names. In order to follow regionally accepted approaches, then, this classification scheme departs somewhat from the type-variety system's specific criteria for assigning names to groups and subtypes. The following is a description of the 15 types and varieties recorded in the Purén and Lumaco Valley. This same typology is applicable to the Liucura Valley collection. Any differences in the latter are noted.

Appendix II presents sherd rim profiles and, when measureable, rim profile/circumference drawings from PU-165 and other sites in the Purén and Lumaco Valley and from sites in the Liucura Valley. The drawings are organized by surface and excavation provenience. Also provided in this appendix are site distribution maps for each ceramic type in the Purén and Lumaco Valley. The chronological periodization of excavated levels at sites PU-122, PU-132, PU-157, and PU-165 is roughly as follows: levels 1 and 2 date to the EH period; levels 2 and 4 date to the LPH period; and levels 5 through 7 date to the EPH period.

It is important to note that INAA and petrographic analyses were not applied to all sherds; only a representative sample was analyzed. Where applicable, the results of these analyses for each sampled type are described. Appendix III shows the number of sherds by ceramic type for surface collected and excavated sites in the study area.

*Ceramic Typology*

**Type 1, Purén**: Included within this group are specimens that are tempered primarily with homogenous, fine to moderate granite particles. This type is divided into varieties 1A and 1B, as discussed below.

Most specimens assigned to this type are densely tempered with coarse angular to subangular particles. Others are densely tempered with fine to medium-sized angular to subangular particles. Temper particles are generally less than 0.05 mm in size; coarse particles are about 1.0 mm in size. The petrographic analysis indicates that most Type 1 sherds are tempered with various kinds of granite. Syenite appears less frequently.

The paste occasionally contains inclusions of granite, mica, schist, muscovite, and other materials. The paste is homogenous in structure and has a chalky, fine but slightly gritty surface. INAA analysis indicated the presence of thorium, hafnium, barium, sodium, lutetium, ytterbium, dysprosium, cerium, terbium, neodymium, europium, and lanthanum in the raw clay sources.

Exterior surfaces are smooth to well-smooth, with tiny sinuous root-like surface marks and often a fine to medium gritty grit. Interior surfaces are either smooth or well-smooth. Exterior surface color is generally medium to dark gray (Munsell range: 5YR 4/1 to 5YR 3/1) to orange and tan (10R 5/6; 2.5YR 5/8 to 2.5YR 4/8; 7.5YR 6/4 to 7.5YR 5/4, respectively), while the interior surfaces are either dark gray/black and tan (7.5YR 4/0 to 7.5YR 3/0). Body sherd thickness ranges from 3.7 to 10.1 mm, with a mean of 5.7 mm. Vessel walls are generally moderately thin.

Vessels occasionally have parallel incised lines or rows of parallel horizontal punctations on the rim just below the lip (see figures at the end of the chapter). Rims are usually slightly excurvate, forming jars with short everted necks, and straight. Lips are rounded and sometimes slightly tapered. A few flat lips also are present. Bases are flat.

Chronology: LPH and EH periods.

Spatial Distribution: Type 1 ceramics were found on the surface at 27 of the 376 sites in the Purén and Lumaco Valley. When present, this type tends to occur in low numbers, with 25 sites yielding less than 10 sherds. One exception is PU-101, a small domestic site that yielded 20 Type 1 sherds. The other is PU-165, a medium-sized domestic site where 28 sherds were found on the surface. This site also received the most extensive excavation; in total, 1,549 Type 1 sherds (n=1,057, PU-165; n=27 PU-122; n=11, PU- 157) were recovered primarily from the late occupation levels of excavated sites. Both of these sites are relatively small (<2 ha), compared to some of the larger sites (>3 ha) that yielded fewer Type 1 sherds. This suggests that the high frequency of Type 1 sherds is not necessarily due to site size but attributable to behavioral patterns.

Sites containing Type 1 sherds are evenly distributed across the Purén and Lumaco Valley. There are no clear areas of concentration; however, the southwestern portion of the valley is noticeably free of this type. Another notable pattern is that all sites are located at elevations above the valley floor, with the exception of PU-96, a small domestic site.

Type 1 ceramics also are confined to a limited variety of site types. The majority are domestic sites, mostly small to medium in size, with one large site (>3 ha), PU-120, represented. Two are cemetery sites, one of which is also a medium-sized domestic locale, LU-17. This site is located near the Lumaco River. The other cemetery site is PU-260, an isolated site located to the north in the hills above the valley floor. In addition, five *kuel* sites produced Type 1 sherds: four small *kuel* located on the Butarincon Peninsula overlooking the northern portion of the confluence of the Purén and Lumaco rivers, and one large *kuel*, PU-38, located in the southwestern portion of the valley.

Variety 1A: These specimens have smoother, finer exterior and interior surfaces. The temper is denser, and is characterized by finer granite particles. Walls are generally thin, from 2.8 to 3.5 mm in thickness, with a mean of 2.9 mm. Exterior surface colors are browns and reddish grays (Munsell range: 7.5YR 5/2 and 5YR 5/2); interiors are dark gray to dark reddish gray) 5YR 4/1 to 5YR 4/2.

Spatial Distribution: Variety 1A sherds were found on the surface at only two sites. At PU-165, 28 sherds were recovered from the surface and 120 from excavation units. The other site is LU-17, where Variety 1A sherds were recovered. Both sites are situated on the eastern side of the study area and both also have 14 and 3, respectively, of unspecified Type 1 sherds.

Variety 1B: Variety 1B is similar to Type 1 and Variety 1A, but is more similar to the latter. Vessel walls tend to be thinner than the other two types, ranging from 2.5 to 3.2 mm in thickness, with a mean of 2.8 mm. Exterior and interior surfaces are grittier and more heavily cracked on these specimens than other Type 1 sherds, perhaps due to larger particles of temper primarily composed of granite and feldspar. Surfaces have tiny holes (<1.0 mm). Exterior color ranges from reddish brown to a dark brown (Munsell range: 5YR 4/3 to 7.5YR 4/4). Interior colors range from reddish gray to brown (10R 5/1 and 7.5YR 4.1).

Spatial Distribution: Variety 1B sherds were only recovered from PU-165. All 50 sherds assigned to this variety were recovered from excavated contexts.

**Type 2, Lumaco**: This type is similar to Type 1, but the temper consists of coarser and denser granite particles.

Temper particles range from medium to large rounded to subangular granite, feldspar, and other materials (e.g., shell, grog). The granite particles are homogeneous, opaque, sub-rounded and sub-angular. The petrographic study reveals that most Type 2 sherds have temper of amphibole, biotite, and granites, as well as quartz sands and a few mica schist particles. Syenite appears less frequently.

Paste texture is laminated and blocky; surface is often orange in color and irregularly, but sometimes completely, oxidized. The INAA study indicates that the clays used to make these ceramic are composed of thorium, hafnium, barium, sodium, lutetium, ytterbium, dysprosium, cerium, terbium, neodymium, europium, and lanthanum particles.

Surface treatment is smooth with occasional rough surfaces caused by medium to large temper particles. Exterior and interior surface colors are medium orange and sometimes a medium to dark gray to medium dark tan (Munsell range: 7.5YR 5/6 to 5YR 5/8; 5YR 3/1; and 7.5YR 4/4). Interior surface colors are a light tan to a dark gray (5YR 6/3 to 5YR 3/1). None of the specimens are decorated. Sherd thickness ranges from 5.7 to 12.8 mm, with a mean of 8.9 mm. This mean is much thicker than the mean of 5.7 mm for Type 1 sherds.

Rims and necks are generally long with everted and straight rims. Lips are rounded to slightly tapered. Flat lips occur infrequently. In the upper levels of PU-165, Type 2 rims are pointed with rounded lips. Flat strap handles occasionally are associated with this type. Bases are flat.

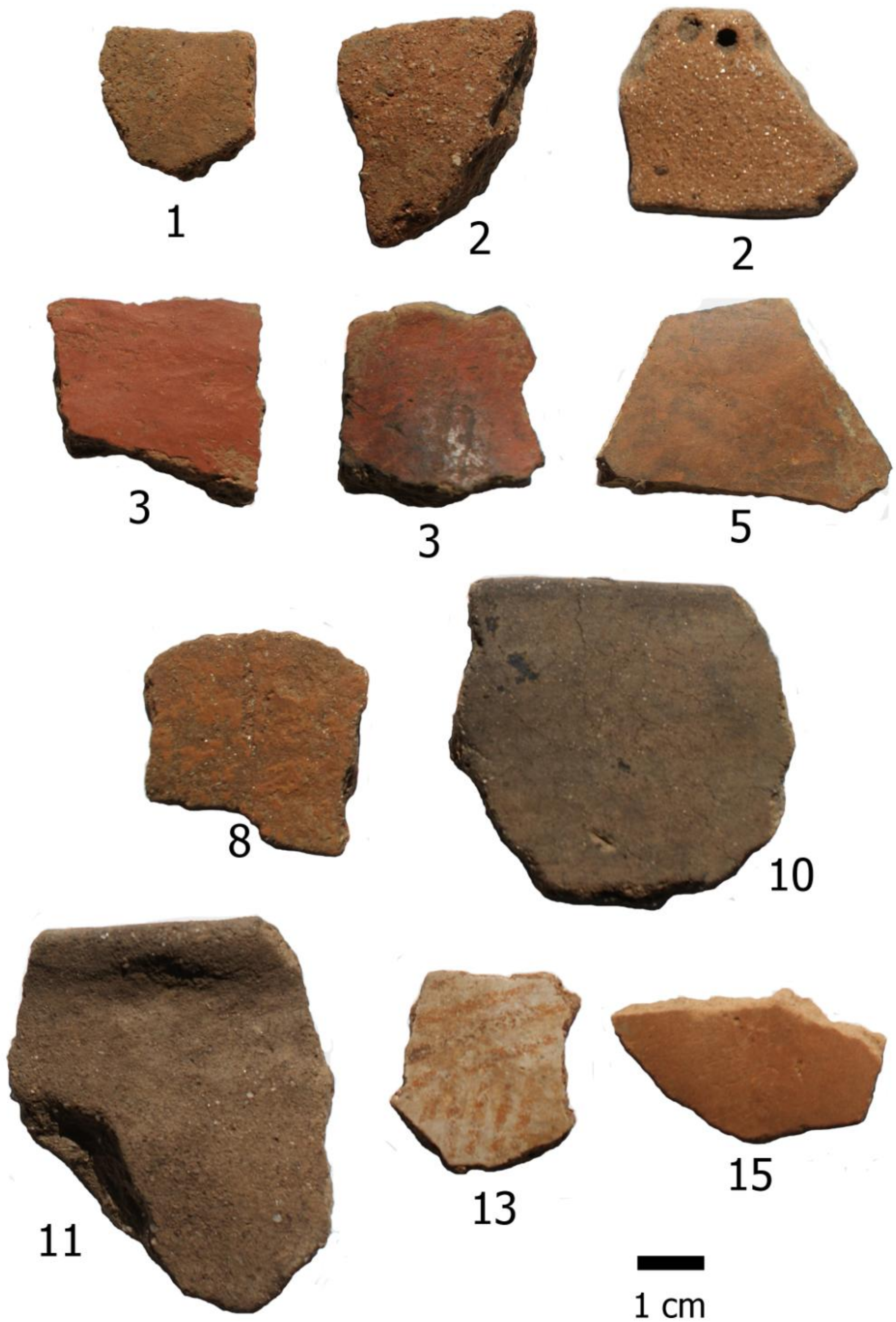



Figure 3.1: Sherd examples for Types 1, 2, 3, 5, 8, 10, 11, 13, and 15.

Chronology: EPH to EH periods. This type is found primarily in the middle to late levels at site PU-165, although it occasionally appears at many other sites in the valley. It is the most prevalent ceramic type in the valley (see Appendix III).

Spatial Distribution: This ceramic type appears to be the most common in the survey area being found at 103 of 376 sites in the Purén Valley. While it is not ubiquitous, it is found at a large number of sites of various types, in relatively large numbers, and is distributed evenly across the entire survey area. Of the 103 sites where Type 2 ceramics were found, 26 sites yielded more than 10 sherds from surface contexts. This may not appear to be a large number, but when compared to the frequency of other ceramic types at other sites, it is noteworthy. Particularly noteworthy are two sites, PU-165 and PU-120. At PU-165, 113 Type 2 sherds were found on the surface, and 5,336 were recovered from the upper and middle levels of excavation units. At PU-120, a large domestic site (~19 ha), 83 sherds were found on the surface, and 180 were recovered from all excavation levels.

Type 2 ceramics were found at a variety of site types. The most frequent were domestic, with 77 sites. In addition, there are 16 *kuel* sites and one domestic/*kuel* site (PU-113) that are regularly distributed across the study area. Two fortresses (PU-8 and PU-26) produced this type, both of which are located on the western side of the valley. Also included are two cemeteries: PU-54 in the south-central valley and PU-260 in the hills to the north of the valley, as well as one domestic/cemetery, PU-89, located directly on the Purén River in the center of the valley. A single *Cerro Sagrado* site produced Type 2 ceramics, and LU-49, located on the south side of the Lumaco Valley near several domestic sites, also yielded Type 2 sherds. This type also is found at two fields channelized by a meandering stream (PU-81 and PU-98) and at one agricultural terrace (PU-118). All three of these sites are located in the central Purén Valley, and along with several domestic sites, which also contain Type 2 ceramics, are part of a floodplain agricultural complex located near the confluence of the Ipinco, Guadaba, and Purén drainages.

**Type 3, El Vergel**: Most of these specimens are tempered with fine to medium granite particles, although mica and sometimes feldspar occur in small amounts. The physical characteristics of the temper particles are the same as those described primarily for Type 1 and infrequently Type 2. The petrographic study shows primarily granite and mica schist tempers. The paste ranges in texture from medium to fine, with most specimens being of medium texture. The INAA study reveals clays composed of antimony, arsenic, cesium and less so thorium, hafnium, barium, sodium, lutetium, ytterbium, dysprosium, cerium, terbium, neodymium, europium, and lanthanum.

Exterior surfaces are well smoothed and exhibit a thin to thick red or occasionally orange slip. Interior surfaces usually are less smoothed and show evidence of wiping. Although the exterior and interior surfaces vary from semi-bright red to an eroded dull, matte red to an orange slip, a few are slightly eroded and show an underlying medium brown to dark red clay body. Slipped exteriors are yellowish red to light red (Munsell range: 5YR 4/4 to 10R 4/8). Interiors range from reddish yellow to brown (5YR 6/6 to 7.5YR 5/2). Vessel wall thickness ranges from 3.8 to 7.6 mm, with a mean of 5.3 mm. Mean vessel wall thickness is slightly thinner than Type 1, but, as with the latter, is much thinner than Type 2 vessels. Type 3 sherds, however, are not as thin as Type 1, varieties 1A or 1B sherds.

Rims are usually tapered and both incurvated and excurvated. Lips are mainly tapered, though a few flat round and lips are present. Bases are flat.

Chronology: LPH to EH periods. This is a late ware type in PU-165.

Spatial Distribution: This type was recovered from the surface of 28 of the 376 sites in the survey area. These sites are small to medium in size, with none larger than 2.0 ha, and are concentrated, for the most part, directly along the main Purén River channel. There is one concentration of sites with Type 3 ceramics stretching along the western portion of the Purén Valley and another concentration scattered along the northern area of the Lumaco Valley. There is a distinct absence of sites containing Type 3 ceramics in the southern portions of both river valleys.

Less than 10 Type 3 sherds were found at a majority of the sites, with three exceptions: PU-165 yielded 29 sherds from surface contexts (an additional 127 sherds were recovered from excavation contexts); LU-19, a small (0.7 ha) domestic site in the northern Lumaco Valley, produced 22 sherds (this is a relatively large number, given the small size of this site); and LU-69, a small (0.6 ha) *kuel* site with 21 sherds (again, a relatively large number given the size of this site). LU-69 is located approximately 1.5 km southwest of LU-19.

There is not much diversity in site types. Most are domestic sites (n=24), with two (PU-116 and PU-89) also having cemeteries. The latter two sites are located directly along the Purén River within 1.5 km of each other. In addition, there is one cemetery, PU-15, also located directly on the Purén River further west. There are three *kuel*: PU-112, slightly north of the Purén River with a single Type 3 sherd; LU-69, as described above; and nearby LU-43 with two sherds.

**Type 4, Ipinco**: Most of the specimens assigned to this type are tempered with fine to medium granite, mainly feldspar particles. The physical characteristics of this type are generally similar to those described for Variety 1B, with a fine homogenous friable paste structure. The petrographic study shows temper is sand quartz, various granites, and mica schist. Paste texture ranges from fine to medium coarse, with most specimens exhibiting a fine to medium paste. The INAA study indicates clays composed of lutetium, ytterbium, dysprosium, cerium, terbium, neodymium, europium, and lanthanum, and less so thorium, hafnium, and barium.

Exterior and interior surfaces are chalky and though exterior surfaces are smoothed, they are also slightly gritty. Interior surfaces are smooth to poorly smooth. Most of the exterior and interior surfaces have a slight matte finish and are moderate brown to medium beige to a greenish, grayish brown, with the majority being a medium to beige to a light brown (Munsell range: 5YR 5/3 to 7YR 5/4; 7YR 3/0 to 10YR 4/2, respectively).

Body sherd thickness ranges from 2.4 to 6.3 mm, with a mean of 5.4 mm. These sherds tend to have thickness that are similar to types 1 and 3, and are much thinner than Type 2. Type 4 sherds are not as thin as varieties 1A or 1B sherds.

Rims generally are straight, with slightly curved and tapered lips, though a few rounded lips are present. Bases are flat.

Chronology: LPH to EH periods.

Spatial Distribution: Type 4 ceramics were found at 10 of the 376 sites. All were located in the eastern portion of the study area, except for PU-38, a medium-sized *kuel* located at the southwestern end of the Purén Valley. The remaining sites are located along the northwest- to southeast-flowing portion of the Purén River and along the Lumaco River.

All sites containing Type 4 ceramics were found either at *kuel* or domestic locales, divided between four *kuel* and six domestic sites. These sites produced less than 10 sherds, with the largest number (n=7) found on the surface at PU-165, a site that contains high numbers of most of the ceramic types found in the study area. Another site that stands out is LU-69, a large *kuel* site overlooking the Lumaco River that also produced a variety of ceramic types. A total of 145 Type 4 sherds were recovered from LU-69. Fewer than three sherds are present at the other eight sites.

**Type 5, Pitrén**: Generally, this is a moderately thick ware, with fine to medium temper. Temper particles present within these specimens are similar to those described for types 1, 2, and 4. A small percentage of specimens assigned to this type exhibit mixed temper, consisting of gritty particles; granite and feldspar constitute more than 50 percent of the temper. The petrographic study shows amphibole and biotite granite, mica schist, and quartz tempers. Characteristics of the paste are similar to those described for types 1 and 4, although the paste has more inclusions and generally is very densely tempered. Paste texture is most often medium coarse to coarse. No Type 5 sherds were part of the INAA study.

Exterior surfaces are either smoothed, with a matte finish (perhaps purposely produced to present a mottled, birch-tree surface appearance) to well-smoothed or occasionally slightly eroded. Interior surfaces are predominately smooth, with a matte finish, but do not have a deliberate mottled appearance like the exterior. The exterior and interior surface color is dark to medium gray to dark brown to medium beige. The exterior surface is always mottled and patchy, with at least two different colors. Exterior and interior colors are nearly consistently the same in color, both ranging from Munsell colors 5YR 3/1 to 10YR 3/3. A few sherds (n= 23) have surfaces that are very finely polished, black to dark brown to gray in color, that are mottled and similar to the classic Pitrén type located south of the Toltén River (Dillehay, personal observation).

Wall thickness ranges from 4.2 to 12.5 mm, with a mean of 8.2 mm, making it one of the thicker types in the collection. A few sherds measured less than 4 mm thick.

Both neckless and necked jars are represented. Rims generally are straight with slightly everted and gently tapered lips. A few lips are flat. Bases are flat. .

Chronology: EPH to LPH periods. This type is one of the earliest in the collection.

Spatial Distribution: This type was recovered from the surface of 10 of the 376 sites in the study area. They are not concentrated in any region, but are well-distributed across the entire study area. No site yielded more than three Type 5 sherds, thus, there are no distinct high density areas. Site types include six domestic sites, one domestic/cemetery (PU-116), one cemetery (PU-260), and two *kuel* (PU-38 and LU-69). Surprisingly, this type was not recovered from PU-65

**Type 6, Trauma**: Temper and paste texture for this type are similar to types 1 and 4, but these specimens are thicker, have smoother surfaces and are lighter in color than these two types. Type

6 sherds also are less gritty than types 1 and 4 specimens because the temper is larger and much less dense.

This type is characterized by large, angular and heterogeneous temper particles, which are generally made up of granite particles. The petrographic study shows tempers similar to types 1 and 2, although more syenite appears. Paste often has tiny, plate-like holes indicating that some temper particles have leached out. Paste texture is fine to medium coarse, with a moderate number of inclusions; it is also blocky. The paste is moderately to densely compact. The INAA study reveals clays composed of antimony, arsenic, cesium and chromium and less so thorium, hafnium, barium, sodium, lutetium, ytterbium, dysprosium, cerium, terbium, neodymium, europium, and lanthanum traces

Most specimens exhibit smooth to moderately smoothed, lightly gritty exterior surfaces, with a slight matte-like finish on a few. Interior surfaces are generally very smooth, more so than types 1 and 4. Exterior surfaces are lighter than those described for Type 1: brown to strong brown (Munsell range: 7.5YR 5/4 to 7.5YR 4/6). Interior surfaces are slightly darker than those of Type 1: very dark gray to dark brown (7.5YR 3/0 to 7.5YR 3/2).

Body sherd thickness ranges from 4.9 to 11.7 mm, with a mean thickness of 9.2 mm. Specimens assigned to this type have some of the thickest vessel walls in the study area. These vessels may have been large storage or cooking vessels. Vessels are generally neckless, though a few specimens have direct necks with rounded and slightly tapered lips. Lips are generally tapered. Bases are flat.

Chronology: LPH to EH periods. This type was recovered from the upper levels at PU-165.

Spatial Distribution: This ceramic type was recovered from the surface of 26 of the 376 sites in the study area. The majority of the sites are domestic (n=20), with one domestic/cemetery (PU-89), one cemetery (PU-260), and four *kuel* (PU-38, PU-166, PU-112, and LU-43). They are generally evenly distributed throughout the study area, though most are located along major rivers or secondary waterways. This ceramic type is not present in the southern portion of the Purén Valley.

All 26 sites yielded less than 10 Type 6 sherds, and no distinct high density areas were present. One noticeable pattern is the association of this type with three large domestic sites. Sites PU-120 (19 ha), PU-69 (17.9 ha), and PU-67 (14 ha) are located in the central Purén Valley within 2 km of each other. Though each yielded only a few Type 3 sherds, they are considerably larger than the majority of domestic sites where Type 6 ceramics are found, as the next largest site is only 5 ha (PU-123) in size.

**Type 7, Angol**: These are thin, very smooth sherds with slightly gritty exterior and interior surfaces. A few thicker sherds, however, were assigned to this type. Exterior surfaces are Pitrén-like (Menghin 1962), with a slightly mottled surface treatment. Type 7 sherds, however, are a light tan or beige color, unlike the dark to medium grays and browns of the classic Pitrén type.

Temper and paste texture are similar to those described for Type 5, except that there are fewer inclusions and the temper particles of granite, feldspar, and quartz are smaller. The petrographic study shows tempers of mica schist and various granites. The paste is characterized by a fine to medium coarse structure. The INAA study reveals clays with thorium, hafnium, barium, sodium, lutetium, ytterbium, dysprosium, cerium, terbium, neodymium, europium, and lanthanum.

Exterior surfaces are very smooth to well-smoothed, with a slightly mottled and matte finish: pinkish gray to brown (Munsell range: 7.5YR 6/2 to 7.5YR 5/4). Interior walls infrequently reveal a mottled appearance, though they are well smoothed and occasionally have a slight matte-like finish. Interior wall colors are dark brown to brown (7YR 3/2 and 7YR 5/2). Body wall thickness ranges from 4.1 to 9.9 mm, with an average of 8.3 mm.

Rims generally are long and slightly everted with tapered and rounded lips. Bases are flat.

Chronology: EPH to LPH periods. This type is primarily associated with the upper levels at PU-165

Spatial Distribution: This ceramic type was recovered from the surface of 29 of the 376 sites in the study area. These sites are evenly distributed throughout the study area, the one exception being a concentration in the northwestern Purén Valley. These are mostly domestic sites, with one fortress, one domestic/cemetery, and one cluster of several small domestic and *kuel* sites on a peninsula overlooking the Lumaco River from the west.

A large number (n=22) of Type 7 ceramics were recovered from PU-122, a mid-sized domestic site in the eastern-central Purén Valley. LU-31, a small *kuel* on the west side of the Lumaco Valley, also yielded a large number of sherds (n=27). When the small size of LU-31 is taken into consideration, this site yielded a high density of Type 7 sherds. One fortress, PU-26, produced two sherds. A few Type 7 sherds were found at a cemetery site, PU-260, and at a domestic/cemetery site, PU-116.

**Type 8, Elicura**: Temper particles present within these specimens are identical to those described for types 1, 2 and 3. This is supported by the petrographic study, which documented temper characteristics similar to those for types 1 and 2. Most temper associated with Type 8 consists of small to medium-sized sand, granite particles. Characteristics of the paste are similar to Type 3, with the exception that Type 8 specimens have more inclusions and slightly larger particles of granite and feldspar. The INAA study reveals clays composed of thorium, hafnium, barium, sodium, lutetium, ytterbium, dysprosium, cerium, terbium, neodymium, europium, and lanthanum.

In terms of surface treatment, this ware differs from types 1 and 2, and is more similar to Type 3. In fact, these specimens could have been classified as Type 3 sherds with an orange or red slip. They were treated, however, as distinct type because of contextual differences, slip colors, and stronger grayish color.

Exterior surfaces are well-smooth to smooth. Interior surfaces are slightly smooth to smooth. The exterior and interior surfaces range in color from reddish brown to yellowish red and from reddish yellow to gray (Munsell range: 5YR 5/4 to 5YR 5/6 and 5YR 6/8 to 5YR 5/1, respectively). Body wall thickness ranges from 2.6 to 3.4 mm, with an average of 3.0 mm.

Rims are straight and everted. Lips are rounded and slightly tapered. Bases are flat.

Chronology: LPH to EH periods.

Spatial Distribution: This type was recovered from the surface of 53 of the 376 sites in the study area. Though found at a relatively large number of sites, only PU-249, a small domestic site that covers 0.6 ha, yielded a high frequency of Type 8 ceramics (n=20). At the remaining sites, from 1 to 14 sherds were recovered, with most sites yielding less than 5 sherds.

Type 8 sherds were found on the surface of a variety of site types, including LU-49, the only *Cerro Sagrado* site at which ceramics were found on the surface. This type also was found at 30 domestic sites, nine *kuel*, one cemetery, one domestic/cemetery, a fortress, and a large channelized field site.

Within the study area, three concentrations of sites containing Type 8 ceramics were documented. One is located in the northern Lumaco Valley. It consists of several small domestic and *kuel* sites situated on both sides of the Lumaco Valley. Another concentration is located in the central Purén Valley. It coincides with a cluster of agricultural sites, including a large channelized field, PU-98, as well as several small domestic sites and a small cemetery site, PU-94. A third concentration is located in the western portion of the Purén Valley. It consists of several small to medium-sized domestic sites, PU-38, a mid-size *kuel*, and PU-8, a small fortress.

At site PU-165 Type 8 sherds were found primarily in the upper excavation levels.

**Type 9, Quitrahue**: The temper and paste texture of this type are similar to those described for types 1 and 7. Most specimens were tempered with slightly fine to medium coarse particles, especially granite and feldspar, and sometimes mica. The petrographic study shows tempers of various granites, quartz sands, plagioclase, and mica schist. The INAA study registers clays with lutetium, ytterbium, dysprosium, cerium, terbium, neodymium, europium and lanthanum and less so antimony, arsenic, cesium, and chromium.

Extetior and interior surfaces are slightly gritty to gritty. Tiny, rounded empty holes are present on the surface, indicating that some erosion of the surface and degradation of temper. Most specimens exhibit smooth and more mottled exterior surfaces that range from light to medium grayish beige to greenish beige (Munsell range: 5YR 4/3 to 7YR 3/4 to 7YR 6/4). Interior surfaces are slightly smoothed to smoothed, matte finish. Colors are dark brown to brown (7.5YR 3/2 to 7.5YR 4/2).

Decoration takes the form of punctations and incised lines that are found on the exterior surface. Punctations may occur as parallel rows and or in groups bounded by incised lines.

As with types 2, 6, and 7, this type is characterized by vessels with relatively thick walls. Sherd thickness ranges from 5.2 to 10.1 mm, with a mean of 8.6 mm.

Rims are associated with necked jars with straight to slightly excurvate rims and slightly tapered to tapered lips. Rims assigned to this type are generally longer and thicker than other types. Bases are flat.

Chronology: LPH to EH periods.

Spatial Distribution: This type was recovered from the surface of 37 of the 376 sites in the study area. These sites are evenly distributed across the entire survey area, with no clear concentrations. There is little variation in types of sites that produced these ceramics. Most are domestic sites, with three domestic/cemeteries (PU-90, PU-116, and LU-17) and five *kuel* (PU-34, PU-111, LU-38, LU-43, LU-62). The only site that yielded a large number of Type 9 sherds from the surface was PU-122 (n=46). Most other sites yielded from 1 to 13 sherds, with most yielding less than 10 sherds.

This type is well-represented in the excavation levels at PU-165. In fact, it was found from throughout the site deposits.

**Type 10, Guadaba**: This type resembles Type 9, but sherds are slightly thicker and darker in color with a pitted, matte exterior surface. Most specimens have granite and mica particles as temper. Interior surfaces are rougher than the exteriors. The petrographic study shows various granites, muscovite, plagioclase, mica schist, and potasic feldspar. Paste texture ranges from slightly coarse to moderately coarse. The INAA study notes clays with lutetium, ytterbium, dysprosium, cerium, terbium, neodymium, europium, and lanthanum and less so thorium, hafnium, barium, sodium.

Exterior surfaces generally are a medium dark gray, although a few light to dark brown examples are present (Munsell range: 5YR 4/2 and 7.5YR 4/2). Interior surfaces are smooth but less so than the exterior surface and are a darker brown in color (5YR 3/1 to 7.5YR 3/0).

As with Type 9, this type is characterized by vessels with relatively thick walls. Walls range between 5.1 mm and 10.0 mm, with an average of 8.5 mm.

Rims are slightly everted and lips are rounded. Some straight short rims and everted rims with tapered lips also occur. Bases are flat.

Chronology: LPH to EH periods.

Spatial Distribution: This type was recovered from the surface of 16 of the 376 sites in the study area. The sites are loosely grouped, with one small group of five sites in the western Purén Valley and one group of six sites in the northern Lumaco Valley. There are a few isolated sites scattered through the remainder of the valley. There are no sites with high frequencies of sherds assigned to this type, none having more than six in number.

Twelve domestic sites produced Type 10 ceramics. Two *kuel* (PU-166 and LU-69), one cemetery (LU-29), and one domestic/cemetery (PU-116) exhibit these sherd types.

Though this is present in all of the excavation levels at PU-165, this type is primarily associated with the lower levels, where it is found with Type 9.

**Type 11, Futa:** This type has temper and paste texture characteristics similar to those described for Type 2, but the paste is rougher, because the temper particles are much larger, denser, and coarse. A few specimens (n=3) have grog temper. The exterior surface is sometimes gritty, probably because of the coarse temper. The petrographic study shows tempers of plagioclase, amphibole granites, potasic feldspar, quartz, and muscovite. In comparison to Type 2 sherds, these specimens also are thicker and often exhibit cracked surfaces. The paste is more homogenously oxidized than Type 2. The INAA study registers clays composed of thorium, hafnium, barium, sodium lutetium, ytterbium, dysprosium, cerium, terbium, neodymium, europium, and lanthanum.

Color of the exterior and interior walls is medium to dark gray to brown. Exterior walls range from Munsell color ranges from 5YR 3/1 to 4/1 to 5YR 5/6. Interiors are 5YR 4/2 to 5YR 2.5/1.

Wall thickness ranges from 5.1 mm to 12.2 mm, with a mean 9.8 mm. This is one of the thickest types found in the study area.

For a description of the rims assigned to this type, see those for varieties 11A and 11B below. Lips vary widely from flat to round to tapered. Bases are flat.

Chronology: LPH to EH periods.

Spatial Distribution: This type was recovered from the surface of three of the 376 sites in the study area. These sites are fairly widely scattered, with one cemetery site, PU-260, far to the north in the hills above the Purén Valley; one small domestic site, PU-249, in the east-central Purén Valley; and one mid-size domestic site, LU-21, in the northern Lumaco Valley. PU-260 yielded seventeen Type 11 sherds, which is a high frequency, especially given the small size of this site (<2 ha). This high frequency may be due to the use of this type of pottery in grave goods, given that PU-260 is a cemetery. At the other two sites, this type is represented by fewer than five sherds.

Type 11 also was recovered from excavation contexts at PU-165. At this site, it occurs in some of the earliest levels.

<u>Variety 11A:</u> This variety has thicker and coarser walls than Type 11, with dense, larger, and angular particles of gritty temper, mainly granite and feldspar. Temper is visible on the surface. Temper particle size measures between 0.2 and 1.1 mm. Walls generally are thick. Although a few exteriors are smooth and show less temper on the sherd surface, interiors are almost always rough. The exteriors are gray to brown (Munsell range: 5YR 5/1 and 7.5YR 5/4). The interiors are reddish brown to strong brown (5YR 5/4 and 7.5YR 5/6).

These sherds generally represent neckless jars. Less frequent are necked jars and, occasionally, drinking vessels with slightly everted rims and rounded lips. Flat and tapered lips are also present on necked jars. Some incurvate jars occur. Bases are flat.

Spatial Distribution: This variety was recovered from the surface of 31 of the 376 sites in the study area. The sites are evenly distributed across the survey area, with no clear concentrations. There is not much variety in site types, with 25 domestic sites and five *kuel*. LU-49 is the only *Cerro Sagrado* site at which ceramics were found on the surface and it produced one Variety 11A sherd.

Two sites have a noticeably high frequency of Variety 11A ceramics: PU-165 and PU-122. At PU-165, 116 Variety 11A sherds were found on the surface. This is a high number, given the size of the site (2.5 ha). At PU-122, a small domestic site in the eastern-central Purén Valley, 38 sherds were found. This doesn't appear to be a large number in comparison to PU-165; however, it stands out when compared to the remainder of sites that produced this type of ceramic, none of which had more than six sherds. At PU-165, this type predominates from the lower to the upper excavation levels. At PU-122, Variety 11A appears in the upper levels dated to the terminal or LPH to EH periods (see Chapters 2 and 6).

Variety 11B: Sherds assigned to Variety 11B are similar to Type 11 and Variety 11A examples in all aspects except for their smoother and less eroded surfaces, and their smaller temper particles. The vessel walls are as thick the other Type 11 sherds and contain small to medium particles of heterogeneous granite. Exterior colors are reddish brown and brown (Munsell range: 5YR 4/3 and 7.5YR 5/4). Interiors are dark reddish gray and dark brown (5YR 4/2 and 7.5YR 3/2).

Short and flat rims are present. These are inverted jars with tapered lips. Some rounded and slightly excurvate lips also occur. Bases are flat.

Spatial Distribution: This variety was recovered from the surface of 75 of the 376 sites in the study area. The only type that is associated with more sites is Type 2. Sites with Type 11B ceramics are evenly distributed across the survey area, with no clear concentrations. Several sites have high frequencies of Variety 11B sherds, but the only one that stands out is LU-69, a large *kuel* site that produced 41 sherds. LU-21 produced 27 sherds and LU-13 yielded 25, though these are less significant quantities than LU-69, given that several other sites produced between 10 and 20 sherds. All sites with a high number of Variety 11B sherds are located in the Lumaco Valley.

There also was more variation in site types within this variety than most of the other types, with one agricultural terrace (PU-127), one cemetery (LU-61), and two domestic/cemeteries (LU-17, PU-116). Three fortresses yielded Variety 11B ceramics, PU-6, PU-8, and PU-26: all are medium-size fortresses located within 3 km of each other in the western Purén Valley. In addition, there are 12 *kuel* containing Variety 11B ceramics, six of which are located in the northern Lumaco Valley. This may indicate some ritual significance associated with this particular ceramic type. This type appears in nearly all levels at PU-165. At site PU-122, the distribution of Variety 11B appears more like that of Variety 11A, associated in the later, upper levels.

**Type 12, Huitran**: This is a Spanish Colonial type. It is a fine terracotta ware that is often glazed in green, cream, or beige. These are ceramic sherds, not roof tiles or *tejas*. The temper is sand grit, although a few inclusions of granite, feldspar, and mica also appear. The petrographic study shows quartz sands, granites, and potasic feldspar. The paste texture is very fine to medium. No Type 12 sherds were subjected to INAA study.

Both the exterior and interior surfaces are very polished and smoothed. The exterior color is light terracotta (2.5YR 5/8); the interior is a slightly darker (2.5YR 5/6).

The walls range in thickness from 4.8 mm to 9.9 mm, with a mean of 7.2 mm.

Rims generally are short and excurvated though slightly straight examples also occur. Lips are slightly rounded or tapered. Bases are flat and usually ringed and slightly concave.

Chronology: EH period.

Spatial Distributions: This type was recovered from the surface of 18 of the 376 sites in the study area. Most of these are located in the western part of the Purén Valley near the present-day town of Purén, although a few are located near the town of Lumaco.

**Type 13, Valdivia**: This is a classic painted pottery type derived from outside of the valley. The paste is fine to moderately fine, with fine to coarse inclusions of granite, feldspar, and other particles. The petrographic study shows quartz sands, mica schist, and granites. Paste structure is homogenous and compact. Paste color ranges from an off-white to light gray color. No Type 13 sherds received INAA study.

Exterior surfaces, and sometimes interior surfaces, have a thick white slip often painted in various designs that are possibly Inca-inspired. Painted designs are in faded reds, browns, and dark grays (Munsell range: 10R 4/4, 5YR 3/3, 5YR 5/1, respectively).

Rims genrally are short to long and excurvate; a few slightly straight examples also occur. Lips are slightly rounded and tapered. Bases are flat and sometimes ringed and concave.

Chronology: Terminal LPH to EH periods?

Spatial Distribution: This type was recovered from the surface of two of the 376 sites in the study area. Both are domestic sites located in the central and eastern portions of the Purén and Lumaco Valley.

Type 13 ceramics were found in the upper levels of excavated blocks at sites PU-165 and PU-122: PU-165 produced three sherds and PU-122 yielded one sherd.

**Type 14, Spanish Tejas**: These are terracota roof tiles or *tejas* dating to the EH period. These were recovered from 21 sites, mostly near the present-day towns of Purén and Lumaco and a few fortresses lying between these two localities. They were often found with Type 12 sherds.

**Type 15, Exotics:** A few sherds exhibited exotic slips (e.g., maroon, black) and paste types, and were tempered with grog, shell, and/or volcanic ash temper. These specimens were so infrequent that no formal type name was assigned to them. In total, 52 of these sherds was recovered from the surface or from excavated areas at 16 sites, with the majority found within excavation levels at sites PU-165 and PU-122. Their appearance, mainly in the uppermost levels of sites, suggests that the majority of these sherds are terminal LPH or EH in age.

Unassigned Specimens: The petrographic analysis identified several sherds not possessing temper material of the Purén and Lumaco geological formations and classified them as exotics. The INAA study also classified several sherds as exotics which could not be statistically assigned to any of the three chemical composition groups revealed in the Purén and Lumaco sherd collection. The reader should consult Chapter 4 for a fuller discussion of these findings.

Lastly, although not recovered by our field research in the study area, a local Mapuche farmer found a complete ceramic vessel while working in an ancient cementery site located in the Elicura drainage of the northwest sector of the Purén Valley (see Dillehay 2007:103). The vessel form appears to be an Inca-inspired aryballoid (Figure 3.2). The surface traits are smoothed and slightly mottled and somewhat reminiscent of unslipped El Vergel pottery. The paste has not been examined by petrographic and INAA analyses.

Figure 3.2. An Inca-inspired (?) aryballoid vessel from a disturbed cemetery in the Purén Valley.

*Intersite* and *Temporal Comparisons*

For intrasite comparisons, the type site used is PU-165 (see Appendix III). This is due not only to the high density of ceramics recovered from it in comparison to other sites, but also because ceramics of all types were found there during excavation.

One pattern for nearly all ceramic types at PU-165 is the variety and large number of sherds in levels 1 and 2, which date primarily to the EH and LPH periods, respectively (see Chapter 5). For some types, such as Type 6, this high frequency reflects increasing or decreasing frequency through time. But for most types, the number of sherds in levels 1 and 2 is much larger than the numbers in other levels. This increased sherd frequency in levels 1 and 2 is not due to post-depositional processes, such as flooding or plowing. The site is too highly elevated for flooding, and it was not plowed until 2009 when trees were planted there for the first time. A similar pattern occurs at sites PU-122 and PU-157, though they are not planted in trees.

In the excavations at PU-122, the highest sherd frequencies appear in level 2, which is roughly contemporaneous with levels 1 and 2 at PU-157 and PU-165. The reason for this patterning most likely relates to more intensive use of those sites by later, larger, and more culturally diverse populations during the terminal LPH, but more likely, EH periods.The distribution and frequency counts for types at the three major excavated sites, PU-122, PU-157, and PU-165, are presented in seriation charts (see Figures 3.3-3.13). A discussion of the distribution of each ceramic type is presented below. The EH period generally is represented by levels 1 and 2 in sites PU-122, PU-157, and PU-165; the LPH period generally corresponds to levels 2 and 3 in sites; and the EPH period is equal to levels 4 through 7 in sites (see Chapter 5).

Type 1 is most common in levels 1 and 2 at all three sites, and at these sites, it decreases in frequency in the lower levels. While Type 1 sherds appear within the lowest levels in low frequencies, their presence indicates that they were among the earliest ceramic vessels used at PU-165, and the popularity of this type increases through time.

A few Type 1 sherds also were found on the surface of PU-165. While Type 1 ceramics do not occur in nearly as high frequencies elsewhere, this pattern of few sherds on the surface, but with higher frequencies in levels 1 or 2, is supported by the ceramic evidence from PU-122 and PU-157. The paucity of Type 1 ceramics on the surface of many sites may be explained by the lack of plowing and by dense vegetation cover in the environmental contexts with which these LPH and EH sites are associated.

Variety 1A and Variety 1B did not appear until relatively late in time at PU-165. Neither variety is present in deposits below level 2. The absence of these varieties at other excavated sites, such as PU-122 and PU-157, is most likely due to sample size.

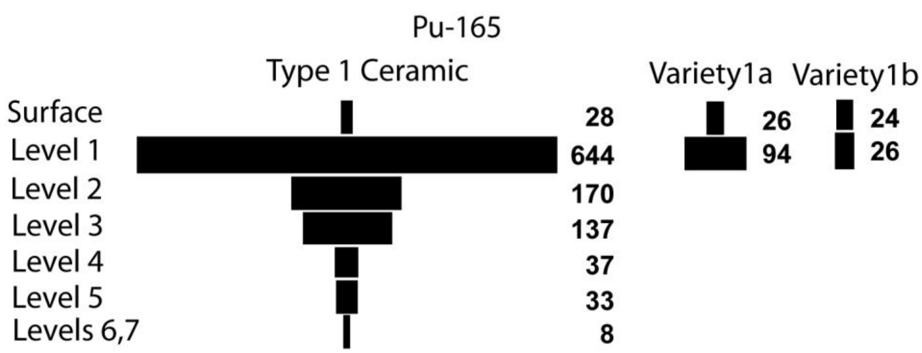



Figure 3.3. Seriation chart of ceramic Type 1 and varieties 1A and 1B at site PU-165.

The distribution of Type 2 ceramics is more difficult to interpret, given the inordinately high quantity of sherds found in level 1. At PU-165, Type 2 ceramics were present from the earliest ceramic time period, increasing in frequency to a maximum in level 1. PU-122 and PU-157 were occupied later than PU-165, but show a similar frequency pattern once Type 2 appears. Few Type 2 sherds appear on the surface of these sites.

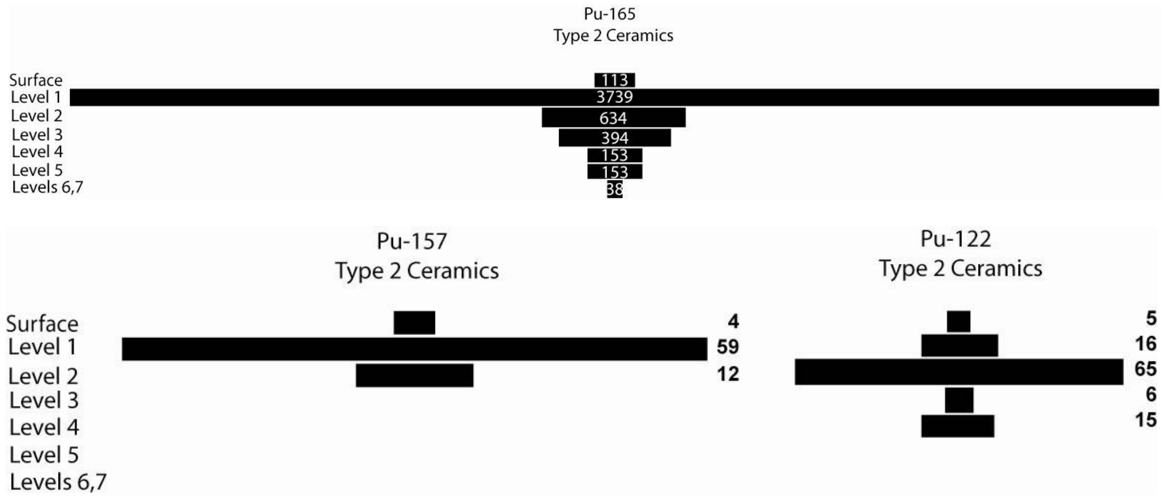



Figure 3.4. Seriation charts of ceramic Type 2 at sites PU-122, PU-157, and PU-165.

Type 3 ceramics are not present below level 3 at PU-165, where they appear in low frequencies, increase slightly in level 2, then rise in frequency in level 1. They are present in much higher quantities on the surface than in the two lowest levels, implying that it is a late ceramic type. A similar pattern occurs at sites PU-122 and PU-157.

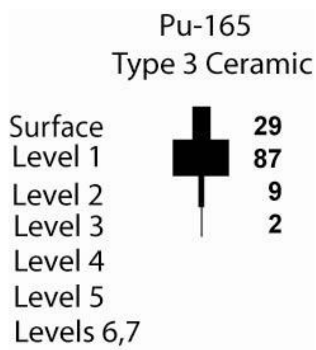



Figure 3.5. Seriation chart of ceramic Type 3 at site PU-165.

At PU-165, Type 4 ceramics appear in levels 4 and 5 in low frequencies and remain so until level 3, increasing dramatically in level 1. Only one Type 3 sherd was recovered from the surface. Except for a much lower than expected frequency on the surface, the vertical distribution of Type 4 ceramics is very similar to that Types 1 and 2, especially in terms of percentages. Once again, a similar pattern is present at sites PU-122 and PU-157.

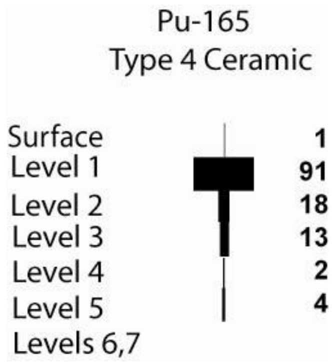



Figure 3.6. Seriation chart of ceramic Type 4 at site PU-165.

Type 5 ceramics are present from the earliest time period at PU-165 (levels 6 and 7), though they appear in low frequencies and remain so throughout the occupation, with an increase in frequency in level 3. There is only one Type 5 sherd in level 1 and no sherds of this type were found on the surface. The same pattern holds for sites PU-122 and PU-157.

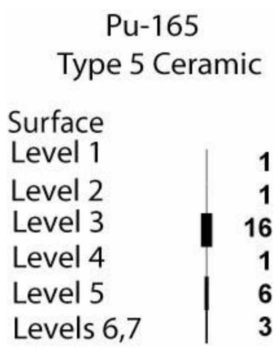



Figure 3.7. Seriation chart of ceramic Type 5 at site PU-165.

Type 6 ceramics appear at PU-165 in levels 6 and 7 and steadily increase in frequency throughout the site occupation to a maximum in level 1. PU-122 and PU-157 present a similar pattern. At PU-165, slightly more than ten percent of Type 6 ceramics were recovered from level 4. In comparison, only about three percent of the sherds classified as types 1 or 2 were associated with level 4.

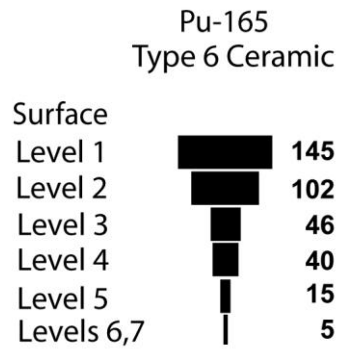
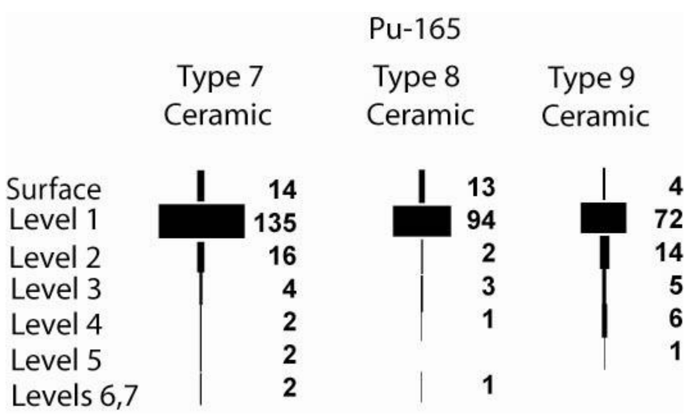



Figure 3.8. Seriation chart of ceramic Type 6 at site PU-165.

Type 7 ceramics at PU-165 appear in low frequencies in levels 6 and 7 and remain in small quantities until an increase in frequency in level 1, then they drop to a low frequency on the surface. Types 8 and 9 follow a similar pattern as Type 7, with the exception that no Type 8 sherds were found in levels 5 through 7 at PU-165. In general, these three types have the same distributional pattern as Type 2.

At site PU-122, types 7 and 8 appear more frequently in level 2 than level 1. Type 7 is at its highest frequency on the surface. Type 8 is at its highest count in level 2. Type 9 is more common at PU-122 than at PU-165. Distribution patterns of these types at PU-157 are similar to those at PU-122.



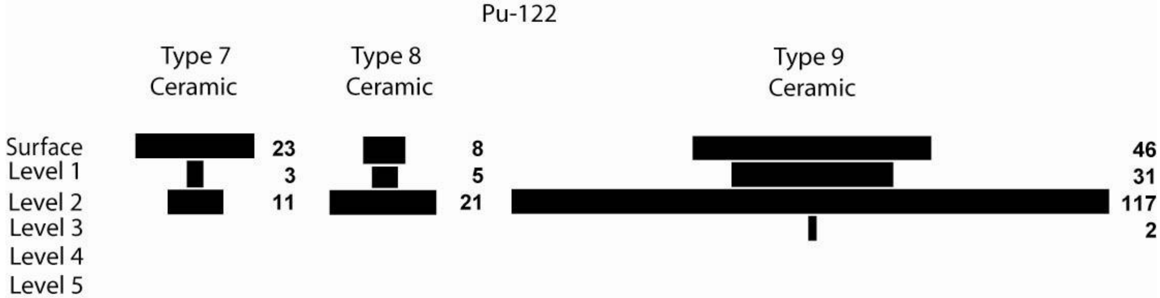



Figure 3.9. Seriation chart of ceramic types 7, 8 and 9 at sites PU-122 and PU-165.

At PU-165, Type 10 ceramics appear in small quantities in levels 6 and 7, are absent in level 5, then reappear in level 4 in small quantities, increasing in frequency to a maximum in level 1, then decreasing on the surface. In general, it has a similar vertical distribution as Type 1. The same pattern is seen at sites PU-122 and PU-157.

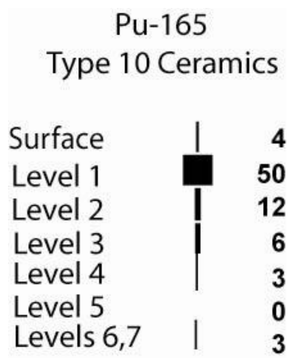



Figure 3.10. Seriation chart of ceramic Type 10 at site PU-165.

Type 11 ceramics appear in considerable quantity in levels 6 and 7 at PU-165. Type 11 sherds increase in frequency until level 4, where they level off, then increase in level 1. There are no Type 11 sherds on the surface. This is the only ceramic type that appears to maintain a constant frequency throughout the entire occupation of site PU-165.

Variety 11A and Variety 11B both appear in levels 6 and 7 in moderate frequencies at PU-165. Variety 11A increases gradually until it increases sharply in frequency in level 1, and terminates with a comparatively large quantity of sherds on the surface. Variety 11B increases in frequency in level 5, decreases in level 4, then increases steadily to a maximum in level 1, with only a few sherds present on the surface. Sites PU-122 and PU-157 show similar patterns.

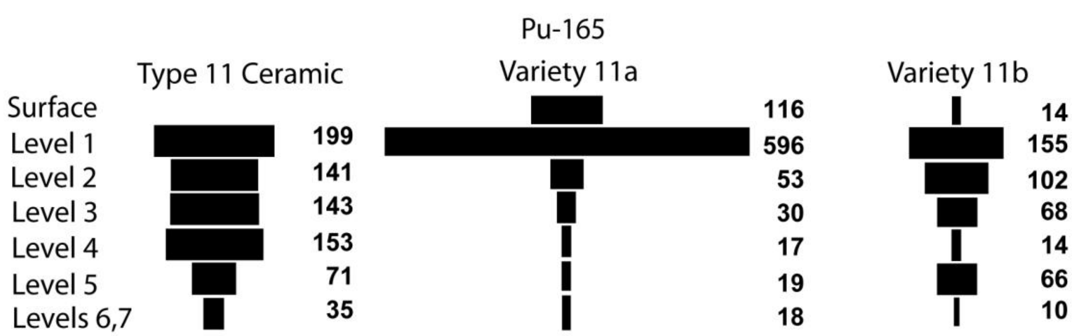



Figure 3.11. Seriation chart of ceramic Type 11 and varieties 11A and 11B at site PU-165.

At PU-165, types 12 and 13 both appear in level 1, but in low frequencies. Type 12 increases to four sherds on the surface, while three sherds of Type 13 appear on the surface of PU-165. This pattern is not surprising, given that both are associated with the terminal LPH and EH periods. Their low frequencies also may indicate that PU-165 was not occupied long into the EH period.

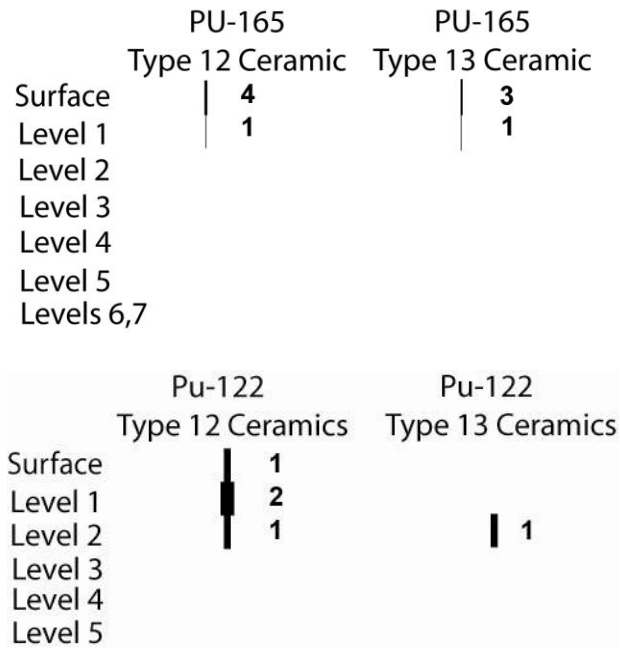



Figure 3.12. Seriation chart of ceramic types 12 and 13 at sites PU-122 and PU-165.

Type 14, ceramic roof tiles or *tejas,* were not recovered at all three excavated sites. Instead, they were found on the surface and in the upper levels of several tested sites, mainly those located near the extreme western and eastern ends of the study area.

Exotic ceramic types are present throughout the occupation at PU-165 in very low frequencies (n=18), with most levels containing only a single sherd. However, there is a pattern of increasing frequency to a maximum in level 1 (n=7).

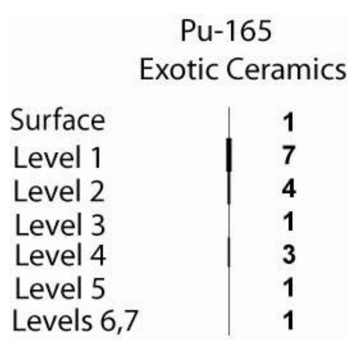



Figure 3.13. Seriation chart of exotic ceramic types at site PU-165.

Based on the seriation of ceramic types recovered from PU-165, PU-122, and PU-157, it appears that once established, certain types were used throughout the sequence, while other primarily were used during the LPH and EH periods. The earliest levels are dominated by types 2 and 11. These two types account for about two-thirds of the ceramics recovered from levels 4 through 6. In the upper levels, Type 2 continues to dominate the assemblage, but there is a sharp drop-off in Type 11. Unlike Type 11, Type 1 remains relatively constant throughout the sequence, relative to other ceramic types.

*Discussion*

With regard to the type-variety classification approach used in this analysis, varieties could have been created for types 2 and 11, particularly in light of the information provided by the combined INAA and petrographic analyses. However, until more sites are tested and more ceramic types are dated in the study area, we prefer to take a conservative approach. This led us to create types with perhaps more variation than might generally be included within a single type.

In this analysis, PU-165 is considered to be a representative type site for the entire study area, particularly since all ceramic types and varieties were recovered there and in patterns similar to those identified at other sites. As more sites are excavated and their ceramic assemblages studied, however, many of the observations presented in this chapter will be altered. Nonetheless, one pattern seems to hold quite well through time and space: more sherds representing more types appear in the later levels of excavated sites, especially during the LPH and EH periods. This pattern is most likely related to a more intensive use of the study area by larger, and more culturally diverse populations during the LPH period, but more likely, the EH period, as postulated in Chapter 1 and discussed later in Chapter 7.

*The Liucura Valley Ceramic Collection*

As with the Purén and Lumaco collection, the vast majority of ceramics recovered from the Liucura Valley are assignable to indigenous wares, although two Spanish glazed sherds and five possible Spanish rim forms were found. The Liucura ceramic collection is distinguished from the former valley by a lower percentage (6.4 percent) of incised and slipped wares, but this figure may reflect a sampling bias. Also in comparison to the ceramic assemblage from the Purén and Lumaco Valley, the collection from the Liucura Valley is much smaller. In total, 521 sherds were recovered from shovel tests and site surfaces in the latter area, and only 53 of these were rim sherds. More comparative study between the ceramic collections from the Purén and Lumaco Valley and Liucura Valley is needed before the typology of the former can be fully applied to the latter. However, based on the this study and on the small collection taken from sites in the Liucura Valley, it can be tentatively suggested that most sherds can be placed into types 1, 2, 4, 5, 7, 9, 10, and 12 to 15 in the Purén and Lumaco Valley. Although Type 3 sherds are also present in the Pucón region and the Liucura Valley, I am not yet convinced that they can be dfined as having the typical attributes of the El Vergel ceramics found north of the Cautín River. More research needs to be carried out on the late orange and red slipped wares in the Toltén River basin and farther south bfore they can more securely be classified as El Vergel.

The Liucura collection is characterized by small to medium-sized jars (*jarros*), pitchers (*cantaros*), and small cooking kettles (*ollas*) with straight necks and short, everted rims (see Liucura rim profiles at the end of this chapter), although a few bowl (*escudilla* n=4) and cup fragments (n=2) were also identified. Most of the latter forms, however, were observed on the surface of and recovered from a small test pit at the Santa Sylvia site, excavated by Americo Gordon (1992) and dated to the terminal LPH and EH periods. Ceramics at Santa Sylvia have been reported by Gordon and briefly by Harcha and Lucero (1999).

Jars or pitchers (*jarros*, *cantaros*, *metawe*) and cooking kettles (*ollas*, *challa*) are the most predominnat vessel form recovered from the Liucura sites. A few sherds represent small cups (n=2, *taza*), slipped plates (n=2, *plato*, *rale*), and bottles (n=1, *botella*). As with other late 13$^{th}$ to 16$^{th}$ century ceramics, handles are primarily intermediate loop straps aad thick straps usually located on the upper shoulder. Although not common (n=3), some handles are bifurcated and nodes were attached to the top of one handle. Drinking vessels or cups displayed looped handles stretching from the lip to the upper wall of the vessel or midway between the lip and the middle wall. The paste colors of the Liucura collection reported here range from beige (Munsell range: 10YR 6/4), black 7.5YR N2/), dark gray (10YR 4/1), reddish (2.5YR 4/4), and dark orangish brown (7.5YR 5/6 and 7.5YR 4/4). The tempers consist of ash, sand, and occasionally slate.

Other than the presence of a white wash or poorly applied slip on two sherds, which Gordon attributed to Spanish influence, and the recovery of two glazed ceramic fragments at Santa Sylvia, no other evidence of a Spanish presence was observed by our survey at other sites, but again, there may be a sampling biased caused by the small collection size. As noted for the Purén and Lumaco Valley, the archeological visibility in the Liucura Valley was limited, perhaps moreso than the former area because vegetation is thicker and there is much less erosion in the latter area.

Ceramics from the Liucura Valley can be recognized as being generally similar to those in the Purén and Lumaco Valley, although sherd tempers from the former valley contain more volcanic ash and different minerals. Further, although we have no quantitative data from the Liucura Valley, there appear to be fewer El Vergel-type sherds and more Pitrén and later Valdivia types than found in the Purén and Lumaco Valley. This is likely not the result of temporal and spatial occupational differences but rather regional differences with El Vergel more closely identified with areas north of the Toltén River and Pitrén and Valdivia with areas farther south of the Imperial River. However, the presence of incised, corrugated, and punctated motifs seems to be prevalent in both valleys, especially during the terminal LPH and EH periods. (These observations are based upon research not only in these two valleys but in other areas of the Araucania investigated by the first author over the past three decades.)

## Chapter 4: Chemical and Petrographic Analysis of Ceramics and Clays from the Purén and Lumaco Valley INAA Chemical Analysis

Leslie G. Cecil and Michael D. Glascock

### *Introduction*

In order to better grasp the complexity of the strategies used to establish and maintain Araucanian hegemony in the Purén and Lumaco Valley, pottery and clay samples were analyzed chemically with instrumental neutron activation analysis (hereafter, INAA). The analyzed samples offer a better understanding of questions regarding the presence of recruited or annexed lineages. If the powerful chiefdom lineages in the Purén and Lumaco Valley recruited distant groups into their lineage, non-local ceramics should be present at late Purén-Lumaco archaeological sites, especially in those levels dating to the EH period. As a result, ceramic variability also should be greater. On the other hand, if the Purén-Lumaco chiefs annexed neighboring lineages and/or territories, one would expect Purén-Lumaco wares to be present at archaeological sites in those territories with less local ceramic variability and the introduction of a few Purén-Lumaco wares. INAA was used to identify the variability in chemical signatures that indicate these possible differences.

### *Methodology: INAA and Pattern Recognition Techniques*

Pottery samples (n=259) and clay samples (n=78) from the Purén and Lumaco Valley were submitted for chemical analysis at the University of Missouri's Research Reactor (hereafter, MURR). Pottery samples included utilitarian specimens as well as 28 stylistic exotics from the archaeological sites in this study. The clay samples were collected from the Purén and Lumaco drainage system and from excavations at PU-132.

Standard MURR procedures (described below) were followed (Glascock 2009, 1992). The samples were washed in deionized water and allowed to dry in the laboratory. Once dry, the individual sherds were ground to powder in an agate mortar to homogenize the samples. Clay samples weighing approximately 400 mg were dried overnight in a drying oven and then fired to 700ºC in an electric kiln. After the clays cooled, they were processed in the same manner as ceramic samples.

Portions of approximately 150 mg of powder were weighed into clean high-density polyethylene vials used for short irradiations at MURR. At the same time, 200 mg of each sample was weighed into clean high-purity quartz vials used for long irradiations. Along with the unknown samples, standards made from National Institute of Standards and Technology (NIST) certified standard reference materials of SRM-1633a (coal fly ash) and SRM-688 (basalt rock) were similarly prepared, as were quality control samples (e.g., standards treated as unknowns) of SRM-278 (obsidian rock) and Ohio Red Clay (a standard developed for in-house applications).

Neutron activation analysis of ceramics at MURR, which consists of two irradiations and a total of three gamma counts, constitutes a superset of the procedures used at most other NAA laboratories (Glascock 1992; Neff 1992, 2000). The 720-second count yields gamma spectra containing peaks for nine short-lived elements aluminum (Al), barium (Ba), calcium (Ca), dysprosium (Dy), potassium (K), manganese (Mn), sodium (Na), titanium (Ti), and vanadium (V). The long irradiation is analogous to the single irradiation utilized at most other laboratories. After the long irradiation, samples had decayed for seven days, and they were then counted for 1,800 seconds (the "middle count") on a high-resolution germanium detector coupled to an automatic sample changer. The middle count yields determinations of seven medium half-life elements, namely arsenic (As), lanthanum (La), lutetium (Lu), neodymium (Nd), samarium (Sm), uranium (U), and ytterbium (Yb). After an additional three- or four-week decay, a final count of 8,500 seconds was carried out on each sample. The latter measurement yields the following 17 long half-life elements: cerium (Ce), cobalt (Co), chromium (Cr), cesium (Cs), europium (Eu), iron (Fe), hafnium (Hf), nickel (Ni), rubidium (Rb), antimony (Sb), scandium (Sc), strontium (Sr), tantalum (Ta), terbium (Tb), thorium (Th), zinc (Zn), and zirconium (Zr) (Glascock 1992).

The analyses at MURR described previously produced elemental concentration values for 33 elements in most of the analyzed samples. Data for Ni in most samples was below detection limits (as is the norm for most New World ceramic analyses) and was removed from consideration during the statistical analysis. After a microscopic examination of the ceramic and clay samples, we determined that the samples had a high frequency of calcite that may affect the results. Because calcium has the potential to affect (dilute) the concentrations of other elements in the analysis, all samples were mathematically corrected to compensate for any possible calcium-included effects (the data were examined before and after calcium correction and the results were similar). The following mathematical correction was used as it has been proven to be effective in other calcium-rich datasets (Cogswell et al. 1998:64; Steponaitis et al. 1988):

$$e' = \frac{10^6 e}{10^6 - 2.5c}$$

where $e'$ is the corrected concentration of a given element in ppm, $e$ is the measured concentration of that element in ppm, and $c$ is the concentration of elemental calcium in ppm. After the calcium correction, statistical analysis was subsequently carried out on base-10 logarithms of concentrations on the remaining 31 elements. Use of log concentrations rather than raw data compensates for differences in magnitude between the major elements, such as calcium, on the one hand and trace elements, such as the rare earth or lanthanide elements (REEs). Transformation to base-10 logarithms also yields a more normal distribution for many trace elements.

The interpretation of compositional data obtained from the analysis of archaeological materials is discussed in detail elsewhere (e.g., Baxter and Buck 2000; Bieber et al. 1976; Bishop and Neff 1989; Glascock 1992; Harbottle 1976; Neff 2000) and will only be summarized here. The main goal of data analysis is to identify distinct homogeneous groups within the analytical database. Based on the provenience postulate of Weigand et al. (1977), different chemical groups may be assumed to represent geographically restricted sources. The locations of sources can also be inferred by comparing unknown specimens (i.e., ceramic artifacts) to knowns (i.e., clay samples) or by indirect methods such as the “criterion of abundance” (Bishop et al. 1982) or by arguments based on geological and sedimentological characteristics (e.g., Steponaitis et al. 1996). The ubiquity of ceramic raw materials usually makes it impossible to sample all potential “sources” intensively enough to create groups of knowns to which unknowns can be compared.

Initial hypotheses about source-related subgroups in the compositional data can be derived from non-compositional information (e.g., archaeological context, decorative attributes, etc.) or from application of various pattern-recognition techniques to the multivariate chemical data. Some of the pattern recognition techniques that have been used to investigate archaeological data sets are cluster analysis (CA), principal components analysis (PCA), and discriminant analysis (DA). Each of the techniques has it own advantages and disadvantages which may depend upon the types and quantity of data available for interpretation. For this analysis, PCA was utilized.

Principal component analysis creates a new set of reference axes arranged in decreasing order of variance subsumed. The individual PCs are linear combinations of the original variables. The data can be displayed on combinations of the new axes, just as they can be displayed on the original elemental concentration axes. Principal component analysis can be used in a pure pattern-recognition mode (i.e., to search for subgroups in an undifferentiated data set) or in a more evaluative mode (i.e., to assess the coherence of hypothetical groups suggested by other criteria). Generally, compositional differences between specimens can be expected to be larger for specimens in different groups than for specimens in the same group, and this implies that groups should be detectable as distinct areas of high point density on plots of the first few components.

It is well known that PCA of chemical data is scale dependent (Mardia et al. 1979), and analyses tend to be dominated by those elements or isotopes for which the concentrations are relatively large. As a result, standardization methods are common to most statistical packages. A common approach is to transform the data into logarithms (e.g., base 10). As an initial step in the PCA of most chemical data at MURR, the data are transformed into log concentrations to equalize the differences in variance between the major elements such as Al, Ca and Fe, on one hand and trace elements, such as the rare-earth elements (REEs), on the other hand. An additional advantage of the transformation is that it appears to produce more nearly normal distributions for the trace elements.

Whether a group can be discriminated easily from other groups can be evaluated visually in two dimensions or statistically in multiple dimensions. A metric known as the Mahalanobis distance (or generalized distance) makes it possible to describe the separation between groups or between individual samples and groups on multiple dimensions. The Mahalanobis distance of a specimen from a group centroid (Bieber et al. 1976, Bishop and Neff 1989) is defined by:

$$D^2_{y,X} = [y - \overline{X}]^t I_x [y - \overline{X}]$$

where $y$ is the 1 x m array of logged elemental concentrations for the specimen of interest, $X$ is the n x m data matrix of logged concentrations for the group to which the point is being compared with $\overline{X}$ being it 1 x m centroid, and $I_x$ is the inverse of the m x m variance-covariance matrix of group $X$. Because Mahalanobis distance takes into account variances and covariances in the multivariate group it is analogous to expressing distance from a univariate mean in standard deviation units. Like standard deviation units, Mahalanobis distances can be converted into probabilities of group membership for individual specimens. For relatively small sample sizes, it is appropriate to base probabilities on Hotelling's $T^2$, which is the multivariate extension of the univariate Student's $t$.

When group sizes are small, Mahalanobis distance-based probabilities can fluctuate dramatically depending upon whether or not each specimen is assumed to be a member of the group to which it is being compared. Harbottle (1976) calls this phenomenon "stretchability" in reference to the tendency of an included specimen to stretch the group in the direction of its own location in elemental concentration space. This problem can be circumvented by cross-validation, that is, by removing each specimen from its presumed group before calculating its own probability of membership (Baxter 1994; Leese and Main 1994). This is a conservative approach to group evaluation that may sometimes exclude true group members.

Small sample and group sizes place further constraints on the use of Mahalanobis distance: with more elements than samples, the group variance-covariance matrix is singular thus rendering calculation of $I_x$ (and $D^2$ itself) impossible. Therefore, the dimensionality of the groups must somehow be reduced. One approach would be to eliminate elements considered irrelevant or redundant. The problem with this approach is that the investigator's preconceptions about which elements should be discriminate may not be valid. It also squanders the main advantage of multi-element analysis, namely the capability to measure a large number of elements. An alternative approach is to calculate Mahalanobis distances with the scores on principal components extracted from the variance-covariance or correlation matrix for the complete data set. This approach entails only the assumption, entirely reasonable in light of the above discussion of PCA, that most group-separating differences should be visible on the first several PCs. Unless a data set is extremely complex, containing numerous distinct groups, using enough components to subsume at least 90 percent of the total variance in the data can be generally assumed to yield Mahalanobis distances that approximate Mahalanobis distances in full elemental concentration space.

Lastly, Mahalanobis distance calculations are also quite useful for handling missing data (Sayre 1975). When many specimens are analyzed for a large number of elements, it is almost certain that a few element concentrations will be missed for some of the specimens. This occurs most frequently when the concentration for an element is near the detection limit. Rather than eliminate the specimen or the element from consideration, it is possible to substitute a missing value by replacing it with a value that minimizes the Mahalanobis distance for the specimen from the group centroid. Thus, those few specimens which are missing a single concentration value can still be used in group calculations.

### *Results*

Data for the 259 pottery samples and 78 clay samples were analyzed using the above statistical methodologies. Even though the ceramic and clay sample proveniences come from a series of small lateral drainages and/or an alluvial plain where the Purén River becomes the Lumaco River and passes by site PU-165 and other sites, three statistically-significant chemical groups of pottery exist within the study area (Figure 4.1). These kinds of drainages usually result in a mixing of river sediments making variability in the clay sources difficult to detect. Therefore, there may be more variability (detectable perhaps with petrography) in ceramic production that is not detected using INAA.

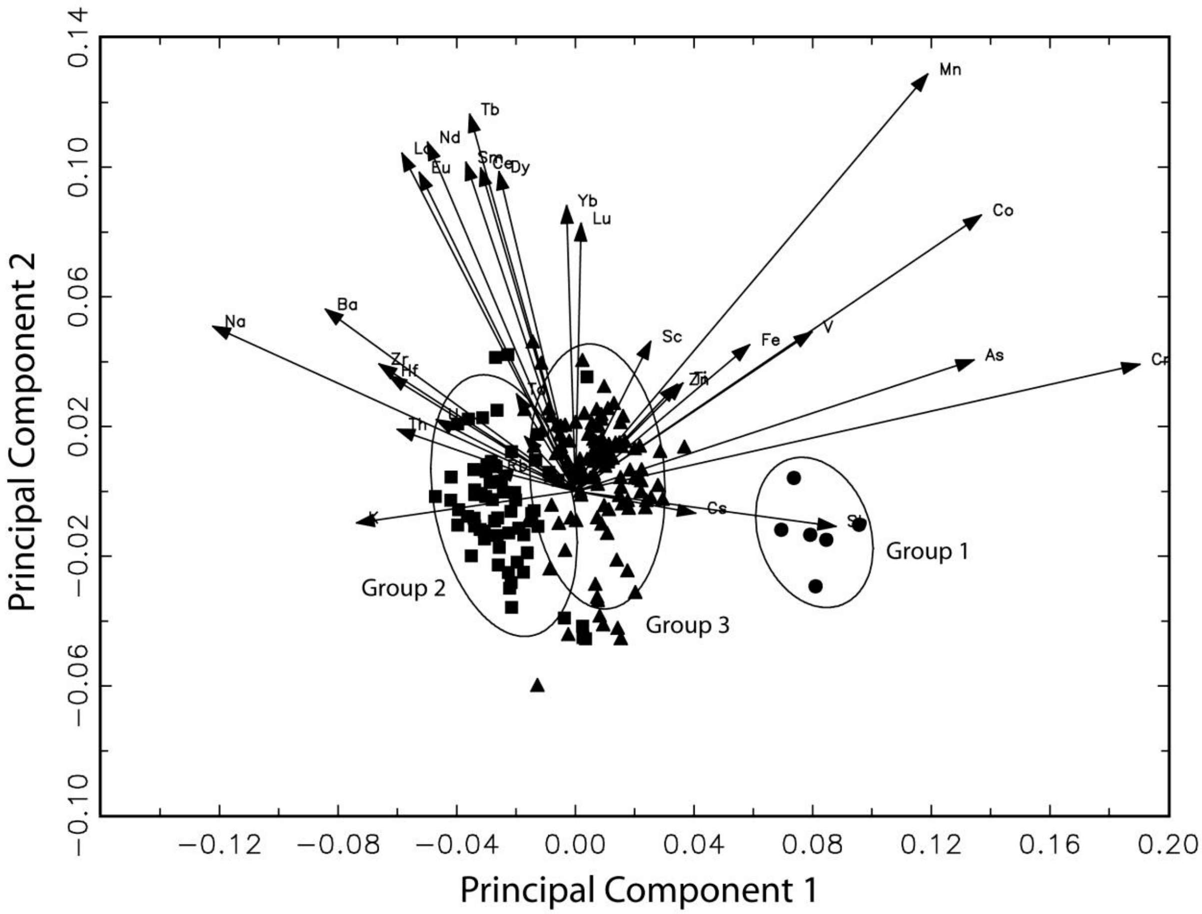



Figure 4.1: Ceramic samples from Huitranlebu, Purén, south-central Chile projected onto the first two principal components with vectors. Ellipses represent 90 percent confidence intervals for group membership.

Pottery Samples:

Pottery samples from the Purén and Lumaco Valley represent three chemical compositional groups. Compositional Group 1 (Group 1 in the figures) is composed of six sherds (one from PU-21, four from PU-165, and one from PU-132). The majority of the sherds represent Type 6 and the remainder was classified as Types 3 and 9 (Appendix IV, Table 1). Compositional Group 1 is defined by its higher concentrations of antimony, arsenic, cesium, and chromium.

Sixty-eight pottery samples were assigned to Compositional Group 2 (Group 2 in the figures). The majority of the sherds were excavated from PU-165, PU-122, PU-157, and PU-120 (in order of relative frequency). Sites PU-21, PU-36, PU-51, PU-123, PU-264, LU-42 and LU-69 are also represented in this group, but with relatively fewer sherds. Type 2 is the most commonly represented ware, although Types 1, 6, 7, 10, and 11 are also represented in approximately equal quantities. Types 3, 4, and 8 occur in minor quantities. This compositional group has higher concentrations of some of the transitional metals and the alkali and alkaline earth metals. There may be a sub-group within this compositional group (see Figure 4.2). Five samples (TDD062, TDD129, TDD290, TDD342, TDD355) have higher thorium, hafnium, barium, and sodium concentrations (Appendix IV, Table 2). When these samples are separated from Group 2 and plotted as a separate group, their structure does not hold and they continue to be statistical members of Group 2. The initial difference may reflect differences in sand tempers.

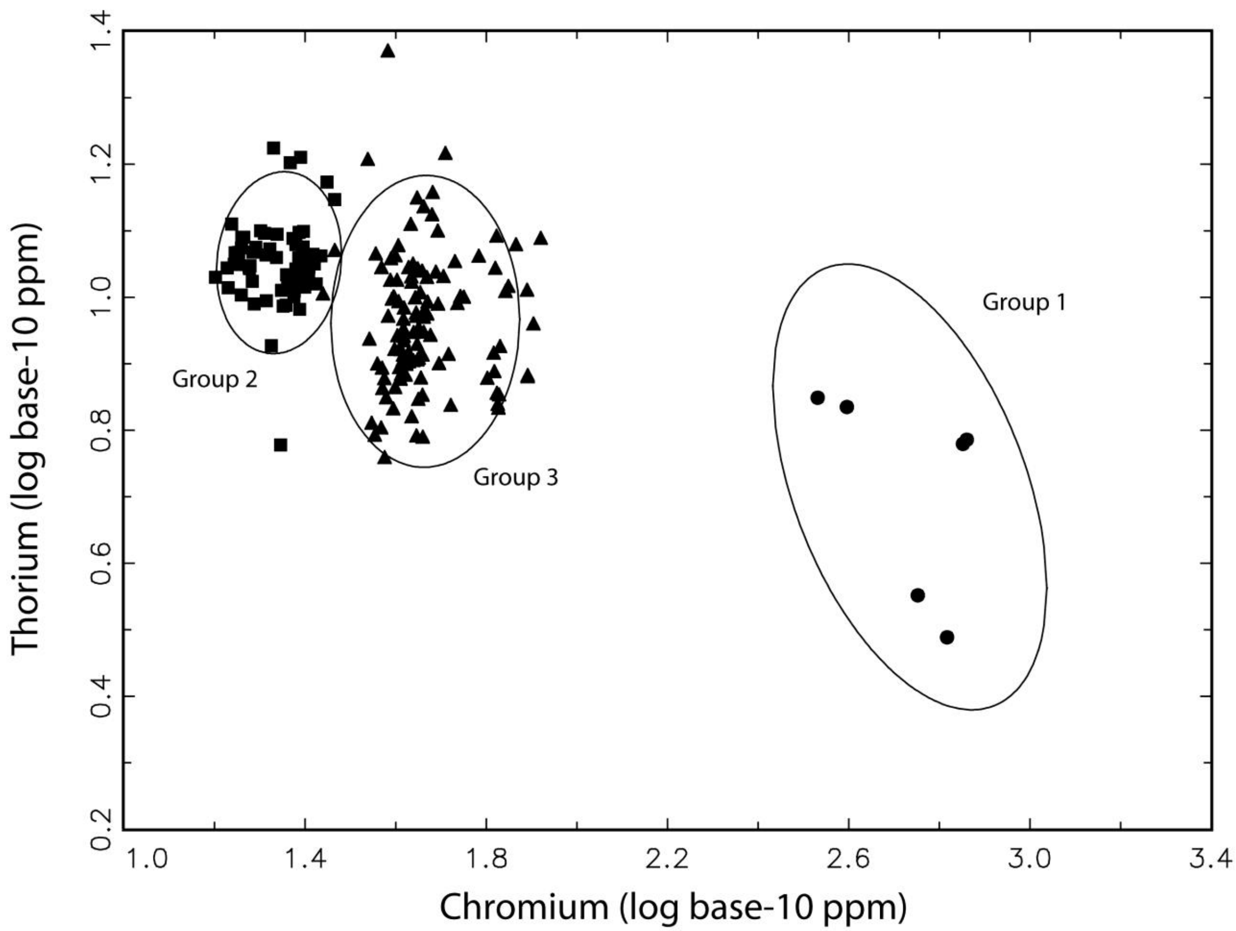



Figure 4.2: Plot of chromium and thorium base-10 logged concentrations showing the separation of the three ceramic groups. Possible sub-structure is seen in Group 2 with five samples with higher thorium concentrations and in Group 3 with 15 samples with higher chromium levels. Ellipses represent 90 percent confidence intervals for group membership.

Compositional Group 3 (Group 3 in the figures) contains the majority of the pottery samples (n=125). The vast majority of these samples were excavated from PU-165, but this group also represents sherds excavated from PU-36, PU-122, PU-249, and LU-69 (with similar quantities ca.

5 sherds per site) and from PU-4, PU-5, PU-21, PU-49, PU-52, PU-65, PU-118, PU-123, PU-136, PU-157, PU-264, LU-41, and LU-42 (with similar quantities 1-3 sherds per site). Similar to Group 2, the majority of the sherds in Group 3 represent Type 2 , but the compositional group also represents Types 1, 3, 4, 6, and 11 in equal proportions (n=11-16 sherds per site), and Types 8 and 9 in equal proportions (n=4), and Types 4 and 10 in equal proportions (n=1-2 sherds per site). Group 3 sherds are enriched in first-row transition metals and the lanthanide series elements (Appendix IV, Table 2). Again, bivariate plots of these data suggest that there may be some sub-group structure (based on chromium frequencies; Figure 4.2), but the sub-group structure is not statistically significant.

The remaining 82 pottery samples could not be statistically assigned to a chemical composition group. The majority (n=11) of the exotics fall into this category. This suggests that the exotics were manufactured using a different recipe or they were not from this region (and they do not match with other samples in the MURR South American database). While the unassigned samples are not statistical members of any of the three compositional groups, bivariate plots demonstrate that the majority of these samples plot within or near the ellipses of Compositional Group 2 and Compositional Group 3 (Figure 4.3). Another explanation for the high number of unassigned samples is that as the Purén-Lumaco River flows through the various archaeological sites, the clays are mixed, resulting in a composite chemical composition representing many clay sources but this is unlikely given the general geological and sedimentological homogeneity of the Purén-Lumaco basin (Pino, personal communication, 2009).

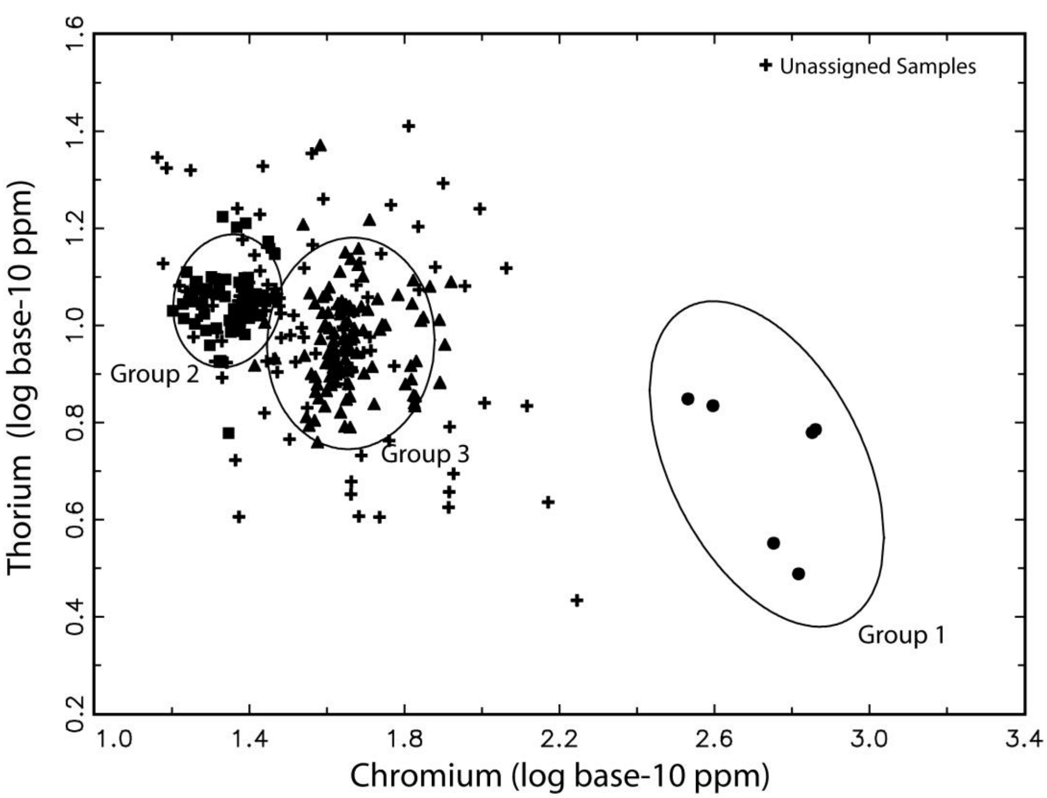


Figure 4.3: Plot of chromium and thorium base-10 logged concentrations showing the separation of the three ceramic groups and the unassigned samples. Ellipses represent 90 percent confidence intervals for group membership.

Clay Samples: Seventy-eight clay samples were analyzed, and only four samples are statistical members of the three pottery compositional groups. These four samples (TDD233, TDD238, TDD242, and TDD326) are statistical members of Compositional Group 3 and were collected from the Purén-Lumaco River basin (Figure 4.4). While the remaining clay samples cannot be statistically assigned to a chemical composition group, two general trends occur. When these data are examined in PCA space (Figure 4.5), two of the clays from excavation contexts at PU-132 (TDD327 and TDD328) and one clay from a non-excavation context (TDD325) plot closer to Compositional Group 1. The remaining clay samples consistently plot in or near Compositional Group 3, but are not statistically members of that compositional group. It is not surprising that few of the clay samples “match” the pottery compositional groups because clay is typically tempered with other materials for pottery manufacture, thus changing the overall chemical composition of the clay that is used in making pottery. However, clays with higher chromium values tend to have been collected from around site PU-165 and those with lower chromium values tend to have been collected from locations further north (this is a very general trend). This trend suggests that with further clay sampling it may be possible to detect a north-south gradient in chromium levels in clays.

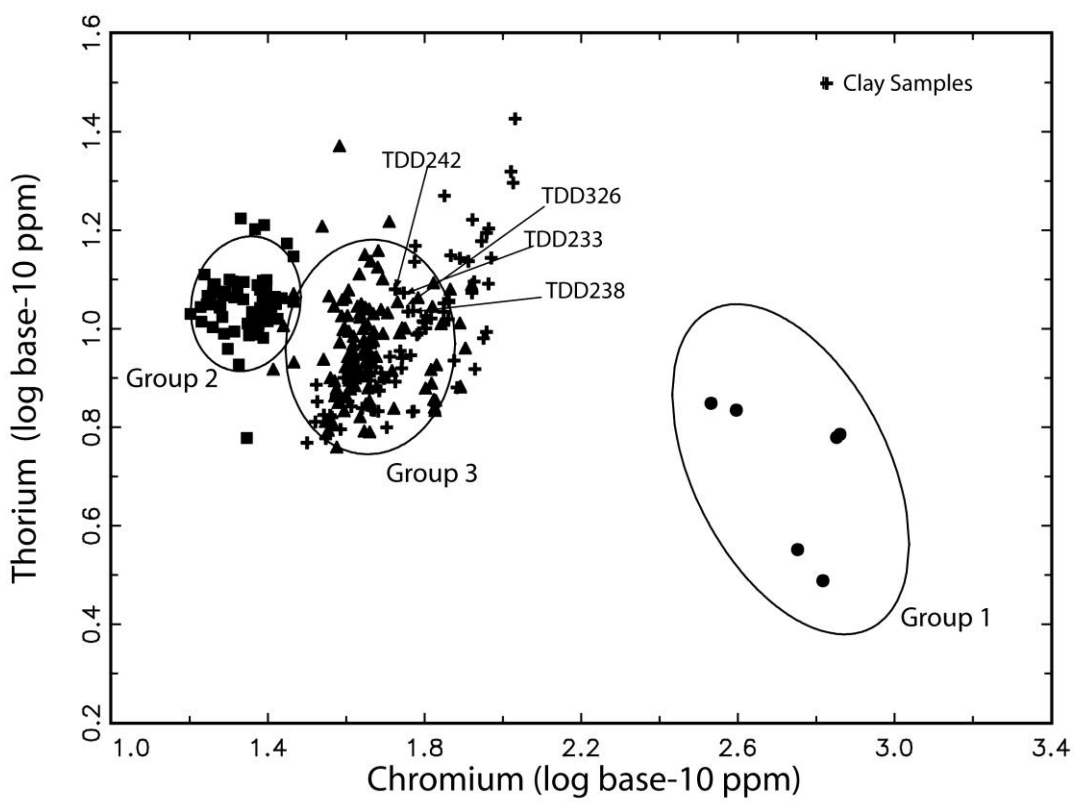
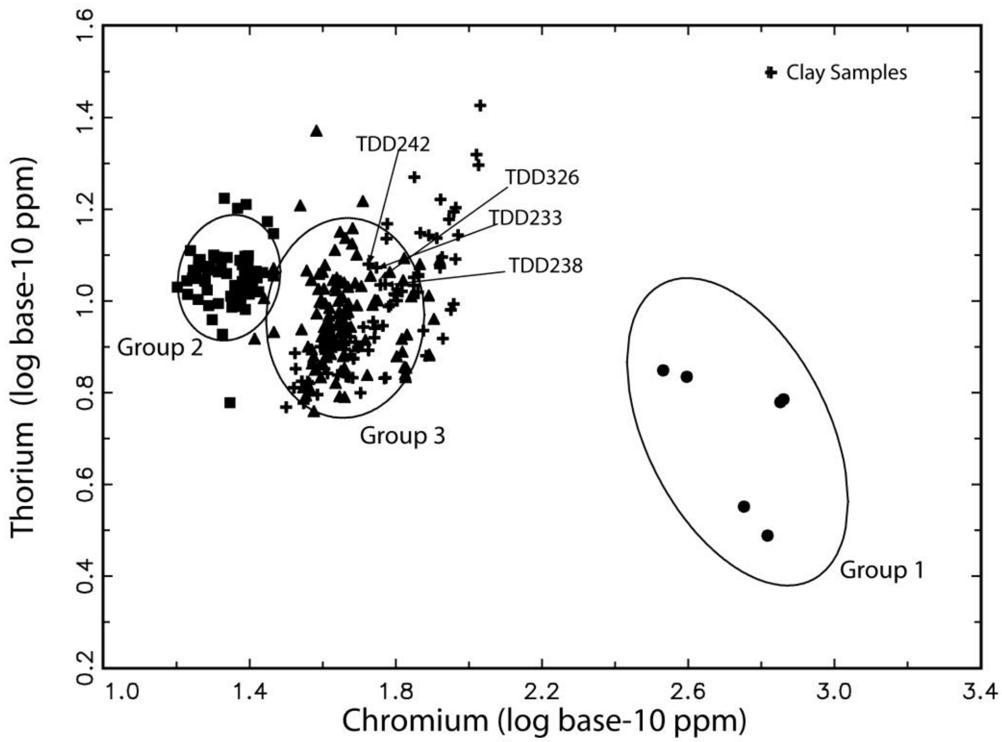


Figure 4.4: Plot of chromium and thorium base-10 logged concentrations showing the separation of the three ceramic groups and the clay samples. Clay samples that are statistical members of Group 3 are identified by their MURR identification number. The remaining clay samples are not statistical members of any of the chemical compositional groups of pottery. Ellipses represent 90 percent confidence intervals for group membership.



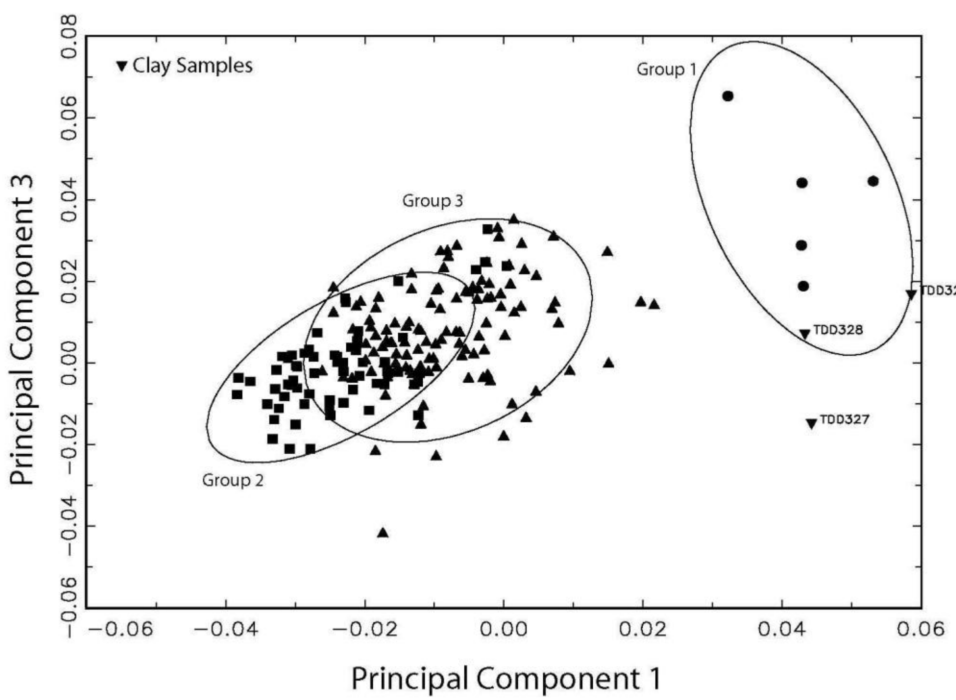



Figure 4.5: Ceramic samples and three clay samples projected onto the first and third principal components. These clay samples (identified by their MURR identification number) show an affinity toward Group 1; however, the clay samples are not statistical members of the pottery compositional group. Ellipses represent 90 percent confidence intervals for group membership.

*Discussion and Conclusion*

The pottery and clay samples discussed above provide some interesting observations about pottery manufacture and distribution in the Purén and Lumaco Valley. Even though there are many pottery samples that remain unassignable to chemical composition groups, most of the pottery seems to be of local production. There are no obvious outliers in these data that would indicate trade from long distance areas such as northwest Argentina or Lake Titicaca (Cecil and Speakman 2005). If one accepts the criterion of relative abundance hypothesis (Bishop et al. 1992), places from which the majority of the pottery are excavated are more likely to be the places of manufacture than other areas where fewer sherds occur, then pottery from Compositional Groups 2 and 3 are most likely to represent pottery manufacture at or near PU-165, given that the majority of pottery in Compositional Groups 2 and 3 were excavated from PU-165. It is possible that Compositional Group 2 also may have been manufactured at or near PU-122, given that almost equal quantities of pottery from Compositional Group 2 occur at PU-165 and PU-122. Additional evidence that suggests that at least Compositional Group 3 represents local manufacture is the "match" of four clay samples to this compositional group.

Compositional Group 1 is a third, most likely local, pottery compositional group. Again, the majority of the samples that represent this group were excavated from PU-165, but there are too few samples in this compositional group to make a secure statement about a possible place of manufacture. This may suggest that these sherds represent a different clay source that was not sampled in this study, perhaps from the Purén-Lumaco basin, a distinct manufacturing recipe (clay and temper) different from Compositional Groups 2 and 3, or trade of pottery or a recruited group from a nearby, but not a Purén and Lumaco Valley location.

A category of exotics also were analyzed (n=24), and if these samples represented true non-local or non-traditional pottery, one would expect them to be unassigned as to chemical group. However, the majority of the samples belonged to Compositional Group 2 or 3 suggesting that the majority of the exotics were not manufactured with a different clay recipe or traded into the area. Therefore, we suggest that some of the exotics were made from local resources and possibly at or around PU-165 in the Purén and Lumaco Valley. Yet, others are clearly made of non-local pastes. Additional analyses and clay samples will need to be analyzed to further examine the hypothesis of exotic pottery manufacture.

The only compositional group that can be securely established as representing local manufacture is Compositional Group 3. Given that these clay samples that are members of Compositional Group 3 are located near PU-165, we would suggest that clays used to manufacture this pottery came from within the Purén and Lumaco Valley.

In sum, these data suggest that the majority of pottery was manufactured within the Purén and Lumaco Valley and may have occurred at or near PU-165. There is no substantial chemical compositional evidence from the pottery and clay samples to suggest non-local manufacture of pottery or extra-regional trade or exchange of pottery. Therefore, these data most strongly support the hypothesis that the Purén-Lumaco leaders annexed some neighboring lineages and/or territories instead of recruiting long distance groups (>50 km) into their lineage. Additional clay samples and analysis of exotics, as well as additional lines of archaeological evidence, will strengthen the hypothesis of the Araucanian hegemony in the Purén and Lumaco Valley.

Acknowledgments: We acknowledge Andrew Crawford, Jonathan Dake, Mark Hammond, Nicole Little, Tessa Schut, and Rebecca Schmidt for their role in preparing the samples for irradiation. Operating support for the MURR Archaeometry Laboratory was provided by a grant from the National Science Foundation (BCS- 0504015). This research was also supported in part by a grant from the US Department of Energy Office of Nuclear Energy, Science and Technology Award No. DE-FG07-03ID14531 to the Midwest Nuclear Science and Engineering Consortium under the Innovations in Nuclear Infrastructure and Education program.

## Petrographic Analysis of Ceramic Specimens

Mario Pino

*Introduction*

Thin-section petrographic analysis was used to identify mineralogical characteristics of inclusions by their appearance, by void shapes and locations, surface treatments, particle orientation, and granulometric features using point counting textural or modal analysis (see Middleton, Freestone, and Leese 1985). Thin-section analysis was also useful for determining some technological aspects, such as raw material treatments and paste preparations (see Freestone 1991: 399). Textural analysis was carried out by counting 150 inclusions per sample using an ocular micrometer, while density of inclusions in the matrix was evaluated through visual estimation charts published by Matthew, Woods, and Oliver (1991). The pottery from the Purén and Lumaco Valley shows a quite heterogeneous mineralogical composition without signs of vitrification. These samples contain inclusions of rounded quartz, feldspar, mica, biotite, muscovite, syenite, and some small fragments of quartzite.Very small amounts of cryptocrystalline calcite are also present throughout the matrix. Despite this relative homogeneity, three groups can be distinguished in specimens from the valley.

The petrographic analysis of the mineral composition of temper permits identification of the source location of the ceramics. This study is thus complementary to the INAA analysis, which examines elements that do not necessarily come from temper minerals but from the clay and water sources of the paste as well as the substances contained in the ceramic or adhering to it after deposition in archeological sites (Stoltman et al. 2005). Petrographoic analysis recognizes the characteristics of the ceramic such as internal and external surface treatments, the presence of oxidized clays, or the use of grog as a temper.

The Purén and Lumaco Valley is located in an eastern portion of the Nahuelbuta cordillera which is part of the coastal mountain range of Chile. The highest part of this range is wets of the town of Angol (~1500 masl). The Nahuelbuta cordillera is composed of a basal Paleozoic cristaline formed by metamorphic and plutonic rocks.

The following geological units are defined for the Purén and Lumaco Valley (Figure 4.6) on the geologic map of Chile (SERNAGEOMIN 2003):

<u>CPg: Carboniferous-Permian.</u> Granites, granodiorites, tonalites and diorites of hornblend, biotite, and muscovite. In the pre-cordillera and principal cordillera of the region there are compound batholites, stocks and hypabissal bodies in the Sierra Morena, the Domeyko Cordillera, and the Elqui-Limarí Batholith. In the principal cordillera of the region, there are the Panguipulli-Riñihue Batholith and the Leones Stock.

<u>DC4: Devonian-Carboniferous</u>: Meta-sandstones, phyllites and, in lesser proportion, marble, cherts, meta-basalts, meta-conglomerates, and meta-turbidites are present with a "*mélange*" facies.  In the far northern regions of the coastal cordillera there is the El Toco Formation and the

Chañaral Epimetamorphic Complex. In the Patagonian cordillera to the far south there is the Eastern Metamorphic Complex of the Provinces of Aysén and Magallanes.

<u>PZ4a: Silurian?–Carboniferous</u>: Schists, muscovites and metabasites, meta-chert and serpentinites with metamorphism with a high P/T grade (Western Series) and metamorphism of the early Carboniferous in the central and south-central regions of the coastal cordillara.

<u>Pz4b: Silurian?–Carboniferous</u>: Slates, phyllites, and meta sandstones with metamorphism of a low P/T grade (Eastern Series) are found in the early Carboniferous of the central and south-central regions of the coastal cordillera.

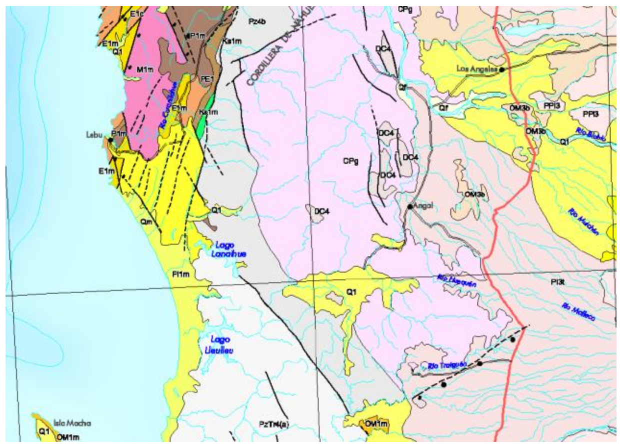



Figure 4.6: Purén sector (in yellow with the symbol Q1) taken from the geologic map of Chile. The pink shades (DC4 and CPg) represent intrusive rocks; the gray areas Pz4a and b represent metamorphic rocks.

The eastern metamorphics rocks series outcrop in the Purén–Contulmo and Lumaco–Capitán Pastene areas, where it is possible to recognize biotite phyllites and metagraywackes (Hervé 1977). The phyllites are fine grained rocks composed of quartz, albite, white mica, chlorite and biotite, with minor particles of garnet and epidot. The metagraywackes have a similar mineralogical composition.

Granitoid plutons outcrop frequently in the Nahuelbuta range between the Río Bío-Bío and Purén River (Hervé 1977). South of Purén, the granitic rocks do not outcrop in the main range, but appear extensively in the low plains near Angol. Both areas are separated by the Purén tectonic depresión, now filled with Quaternary sediments. A section of the granitoid pluton extends north of Purén which is referred to as the Nahuelbuta central pluton; the section south of Purén is the Angol pluton. The two plutons connect at Los Sauces. The typical composition of the granitoids in the Nahuelbuta pluton is: 1) quartz-diorites composed of plagioclase, green hornblende and biotite with minor percentages of quarz and orthoclase; 2) tonalites mainly composed of quartz, plagioclase, hornblende or biotite, and minor K-feldspar; 3) graniodorites composed of quartz, plagioclase, microcline (K-feldspar) and biotite; 4) granites mainly composed of microcline, plagioclase and quartz, with minor percentages of biotite and muscovite; and 5) quartz-rich rocks (syenite) bearing biotite and muscovite as well as feldspar. In the first 4 types, granitoid epidote is an accessory mineral. These types include quartz-diorites and granodiorites, which are mainly composed of plagioclase, quartz and biotite, with minor amounts of hornblende and K-feldspar, and secondary minerals such as epidote, chlorite and sphene (Hervé 1977). In the Angol and Traiguen plutons the rocks are deeply weathered. No volcanic rock outcrops have been described in the area.

*Methods*

Thirty-seven transparent sections were observed under polarized light at magnifications varying between 60X and 250X. The photography was done at a magnification of 32X and 100X. The mineralogy, maximum and minimum modal size, the degree of rounding and weathering were determined for the mineral grains. The petrographic technique used here combined qualitative mineral identification and semiquantitative point counting (Day et al. 1999; Stoltman 1989, 1991). A grid was established over each thin section at 0.1 mm spacing. The microscope stage was moved along these increments and the mineral positioned under the crosshairs of the grid was identified. Also the size of mineral grain was measured. In each case an attempt was made to determine the presence of ceramic fragments included as temper. The total percentage of temper was estimated by comparison with tables. In some cases, when the quality of the thin section permitted, the characteristics of rims were analyzed to determine the presence of paint, slip, smoothing, and other surface treatments. The paste color was described in a general fashion.

*Results*

Appendix IV, Table 3 gives a summary of the observations in the 37 thin sections analyzed. Using the mineral composition of the temper, it was possible to identify three groups of ceramics which share a common rock used for temper. The groups correspond to 1) granite, 2) schist or phyllite, and 3) quartz (Figures 4.7-4.13). Two samples have a temper formed by a mixture of Group 1B and Group 3 (TDD172 and TDD174), and in another sample (TDD173) there is a mixture of temper belonging to Group 2 with the addition of fragments of andesitic rocks. With the exceptions of the last volcanic component, all of these rocks are of local origin.

From observation of the minerals in Group 1, which was divided into Groups 1A-1E, it was possible to determine the presence of different varieties of granite, where the common minerals are quartz, plagioclase, and potasic feldspar; the ferromagnesian mineral varies from amphibole, biotite, epidote, or combinations of a pair of these or the absence of dark minerals. Thus, from a mineralogical point of view, the samples can be classified as seen in Table 1 below. More than half the samples have temper derived from an amphibole granite, about 14 percent have syenite temper, and the rest of the identified rocks have lower percentages. The majority of the Type 2 sherds have tempers of the three granites listed below, especially amphibole granite. Ceramic Types 6, 9, 10, 11, and 12 tend to have some Group 1 granite tempers but also those of Groups 1E, 2 and 3 (Figures 4.7-4.13)

Table 4.1: Groups of Parent Rocks by Mineralogical Analysis of the Temper.

| GROUP | ROCK TYPE | SAMPLES | percent |
| --- | --- | --- | --- |
| 1A | amphibole granite | TDD2, TDD5, TDD7, TDD9, TDD10, TDD11, TDD13, TDD15, TDD16, TDD18, TDD21b, TDD23a, TDD23b, TDD24, TDD25, TDD26, TDD28a, TDD28b, TDD28c, TDD28d. | 58.8 |
| 1B | biotite granite | TDD12, TDD17. | 5.9 |
| 1C | epidote granite | TDD1, TDD3. | 5.9 |
| 1D | biotite/epidote granite | TDD22. | 2.9 |
| 1E | syenite | TDD6, TDD8, TDD21a, TDD29, TDD30. | 14.7 |
| 2 | quartz | TDD14 | 2.9 |
| 3 | mica schist | TDD4, TDD19, TDD27 | 8.8 |
| 1B+3 | biotite granite+mica phyllite | TDD172, TDD174 | 5.4 |
| 3+volc | mica phyllite+andesite | TDD173 | 2.7 |

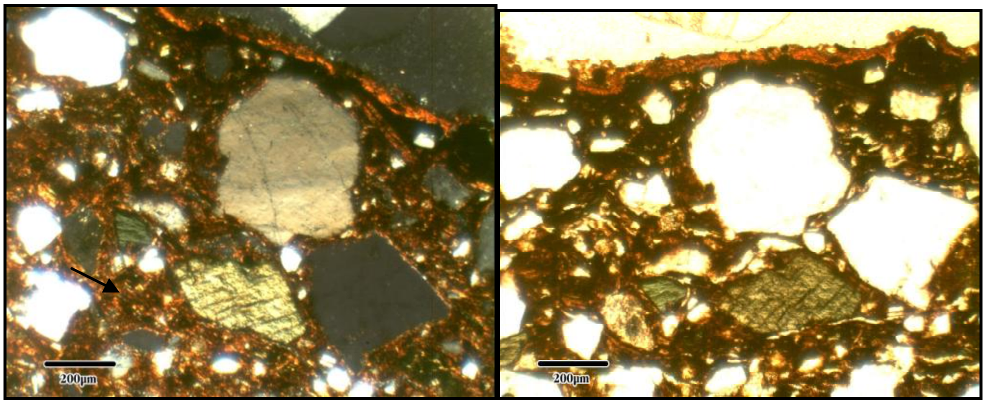



Figure 4.7: Specimen TDD15 represents a Group 1A amphibole granite (hornblende). Left photograph was taken under normal light; right photograph was taken under polarized light.

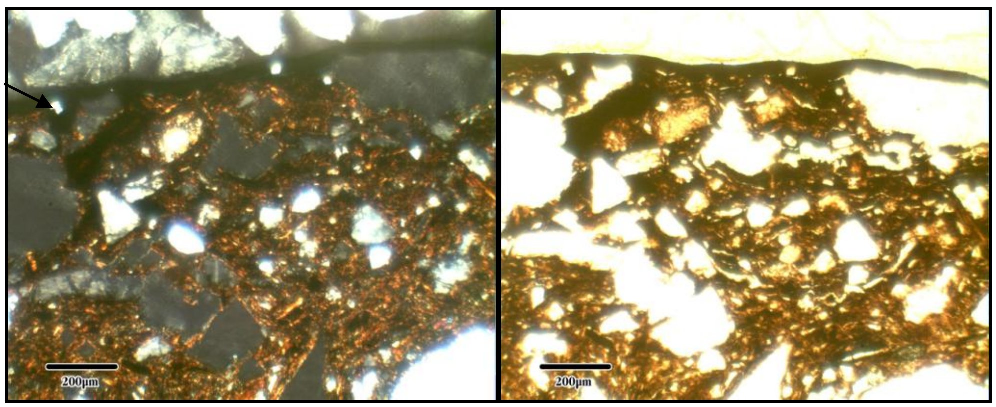



Figure 4.8: Specimen TDD17 represents a Group 1B biotite granite. Left photograph was taken under normal light; right photograph was taken under polarized light.

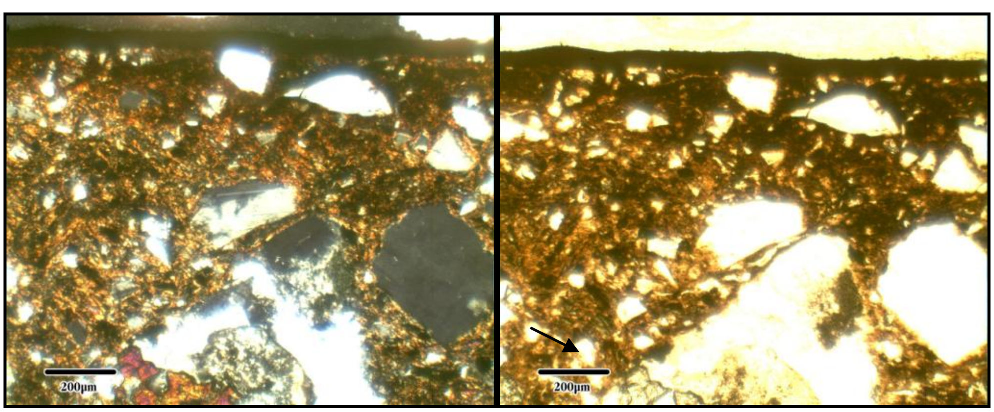



Figure 4.9: Specimen TDD3 represents a Group 1C epidote granite (pistacite). Left photograph was taken under normal light; right photograph was taken under polarized light.

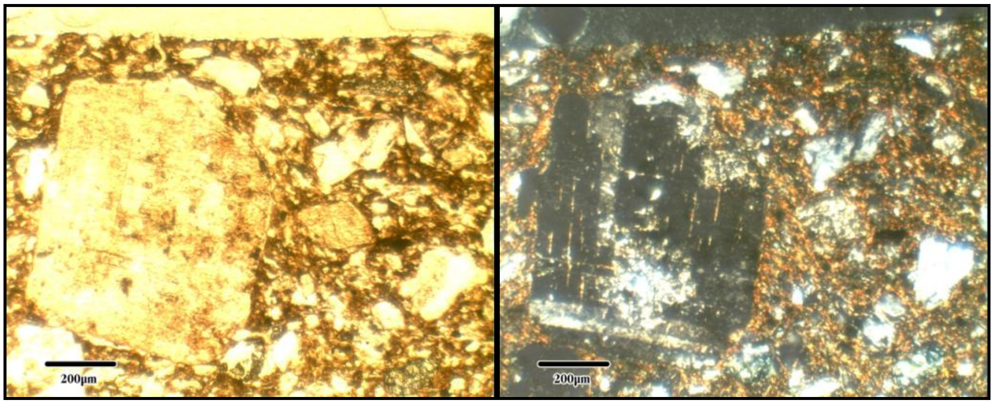



Figure 4.10: Specimen TDD8 represents a Group 1D syenite. Left photograph was taken under normal light; right photograph was taken under polarized light.

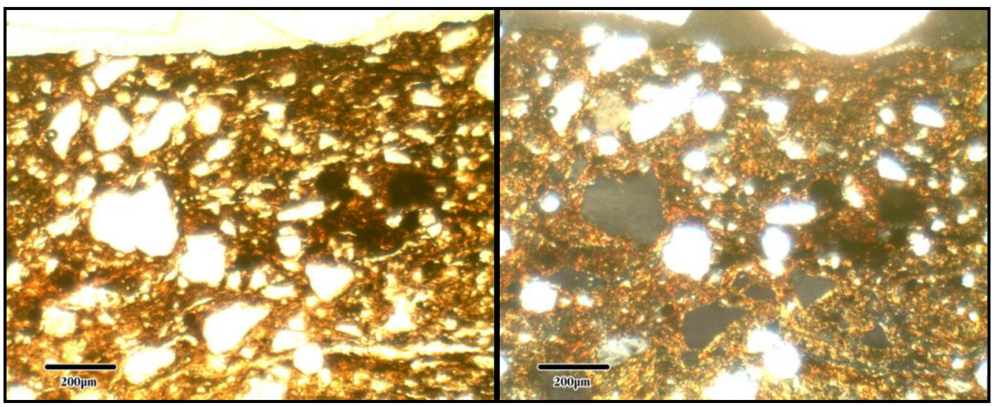



Figure 4.11: Specimen TDD14 represents a Group 2 quartz. Left photograph was taken under normal light; right photograph was taken under polarized light.

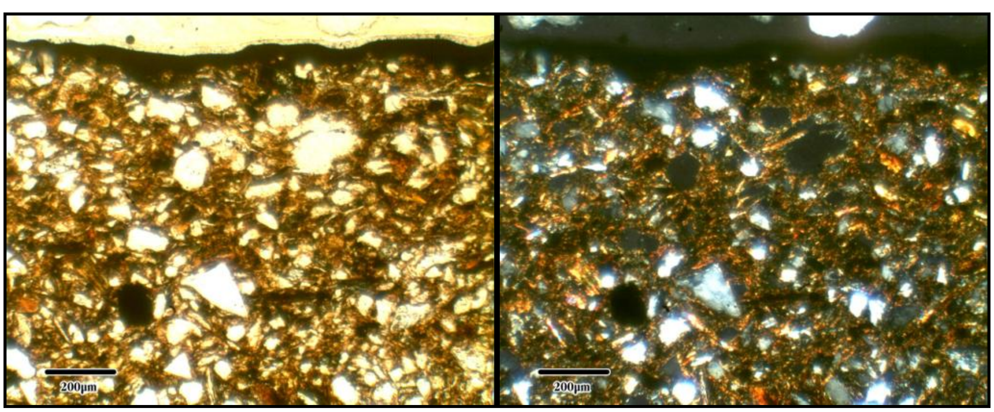



Figure 4.12: Specimen TDD27 represents a Group 3 mica phyllite. Left photograph was taken under normal light; right photograph was taken under polarized light.

The degree of weathering of potasic feldspar and the degree of rounding of quartz grains was used to determine if the temper taken from freshly ground rock, weathered regolith, or sand from a stream. The criterion used was that both the ground parent rock and the granules obtained from regolith would have a higher degree of weathering than the sand from a stream and that the grains from the stream would be more rounded. Table 4.2 shows the degrees of rounding for each one of the seven groups of parent rock. About two-thirds of the sample show moderate rounding and a third shows low to moderate rounding. The category of high rounding is barely represented.

Table 4.2: Degree of Rounding of Quartz in Temper, separated by Parent Rock Group.

| GROUP | LOW TO MODERATE ROUNDING | MODERATE ROUNDING | MODERATE TO HIGH ROUNDING |
|---|---|---|---|
| 1A | 4 | 15 | 1 |
| 1B | 1 | 1 | 0 |
| 1C | 0 | 1 | 1 |
| 1D | 1 | 0 | 0 |
| 1E | 2 | 3 | 0 |
| 2 | 1 | 0 | 0 |
| 3 | 1 | 2 | 0 |
| 1B+3 | 2 | 0 | 0 |
| 3+volc | 1 | 0 | 0 |
| TOTAL | 13 | 22 | 2 |

Figure 4.13 shows an example of moderate to low rounding in specimen TDD5. Figure 4.14 corresponds to moderate rounding in specimen TDD2. Figure 4.15 shows moderate to high rounding in specimen TDD11. All three specimens are of Group 1A amphibole granite.

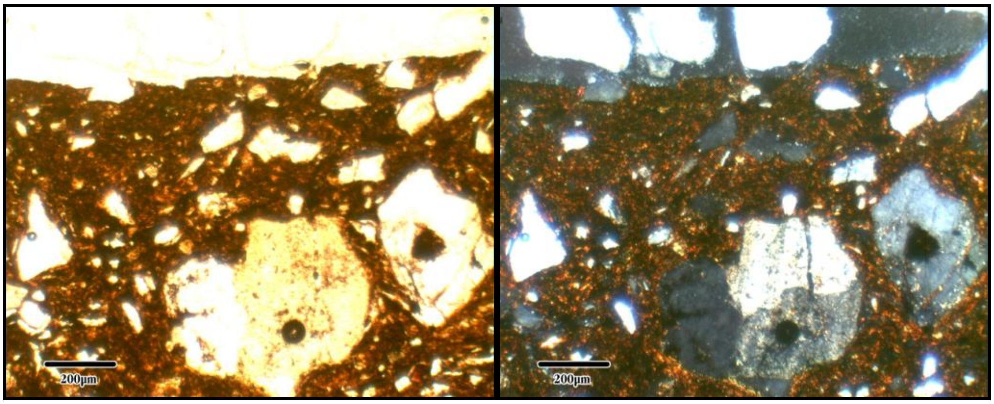



Figure 4.13: Specimen TDD5 with low to moderate rounding of temper. Left photograph was taken under normal light; right photograph was taken under polarized light.

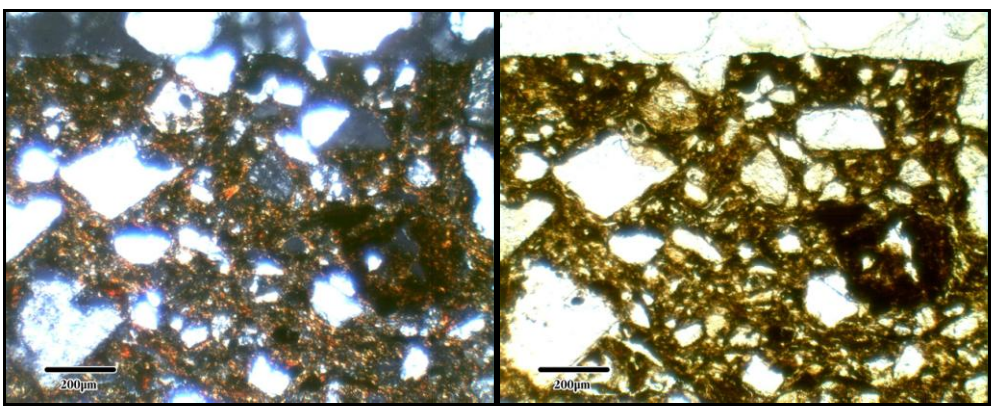



Figure 4.14: Specimen TDD2 with moderate rounding of temper. Left photograph was taken under normal light; right photograph was taken under polarized light.

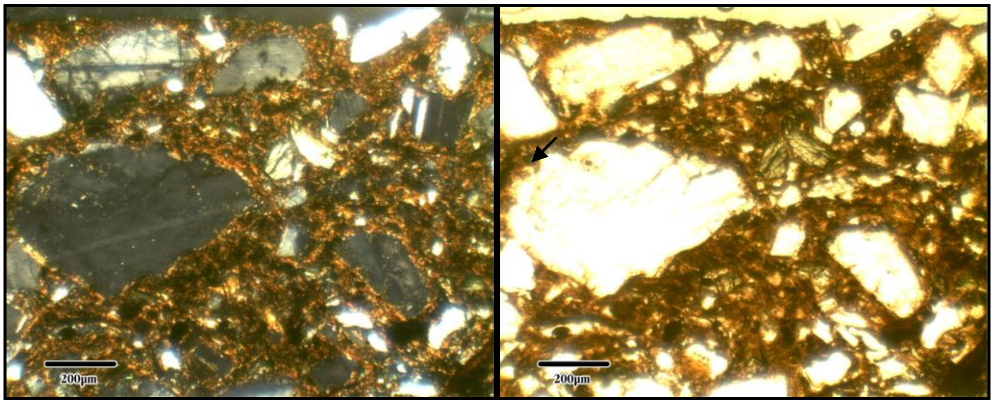



Figure 4.15: Specimen TDD11 with moderate to high degree of rounding of temper. The arrow in the photograph to the right shows an orthoclase crystal of sand temper with no rounding. Left photograph was taken under normal light; right photograph was taken under polarized light.

Since the quartz crystals in plutonic and metamorphic rocks have a certain degree of natural rounding, this criterion did not allow for a clear identification of the presence of ground rock, regolith or fluvial sand. There were a few exceptions like Sample TDD14, made up exclusively of quartz, which had angular grains, interpreted as crushed pure quartz rock.

The degree of weathering of K-feldspar and the degree of rounding of quartz grains was used to determine if the temper was taken from freshly ground rock, weathered regolith, or sand from a stream. The criterion used was that both the ground parent rock and the granules obtained from regolith would have a higher degree of weathering than the sand from a stream and that the grains from the stream would be more rounded. When the criterion of weathering or rounding was applied (see Table 4.2), several important differences were seen, given that a few samples had very fresh potasic feldspars, probably orthoclase and microcline (Samples TDD9, TDD10, TDD11, see Figure 4.15 and Appendix IV, Table 3).

Table 4.3 shows the percentages of temper present in the samples by group. In the majority of the groups, temper varied between 30 percent and 40 percent. In the case of temper derived from schists (Group 3), the highest and lowest values of the whole sample are shown: TDD4 and TDD19, Figure 4.16 and Figure 4.17, respectively.

Table 4.3: Percentages of Temper present in Samples by Group.

| GROUP | 20-30% | 30-40% | 40-50% | 50-60% | 60-70% | 70-80% |
|---|---|---|---|---|---|---|
| 1A | 0 | 4 | 7 | 5 | 4 | 0 |
| 1B | 0 | 0 | 2 | 0 | 0 | 0 |
| 1C | 0 | 0 | 0 | 1 | 1 | 0 |
| 1D | 0 | 1 | 0 | 0 | 0 | 0 |
| 1E | 0 | 2 | 1 | 1 | 1 | 0 |
| 2 | 0 | 0 | 0 | 0 | 1 | 0 |
| 3 | 1 | 1 | 0 | 0 | 0 | 1 |
| 1B+3 | 1 | 0 | 0 | 1 | 0 | 0 |
| 3+volc | 1 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 3 | 8 | 10 | 9 | 6 | 1 |

The size of the grains of temper corresponds to sand, with a few exceptions. The minimum size varies between 0.05mm and 0.2mm, with an average of 0.09mm (very fine sand). The maximum size varies between 0.4mm and 3.0mm, with an average of 1.23mm (very coarse sand). The mean varies between 0.2mm and 0.5mm with an average of 0.37mm. In general the selection of size of the temper is small, with very heterogeneous distribution.

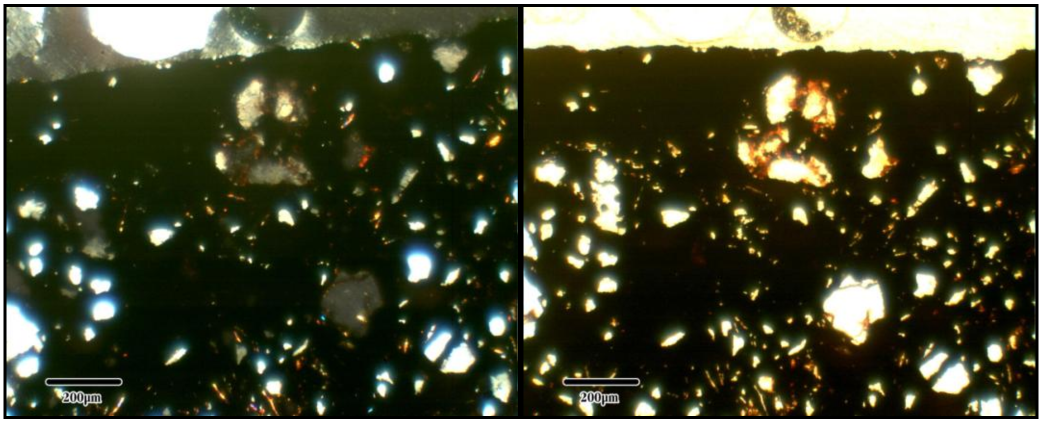



Figure 4.16: Specimen TDD4 with 20 percent to 30 percent of temper and a dark paste, which probably reflects a high amount of hematite. Left photograph was taken under normal light; right photograph was taken under polarized light.

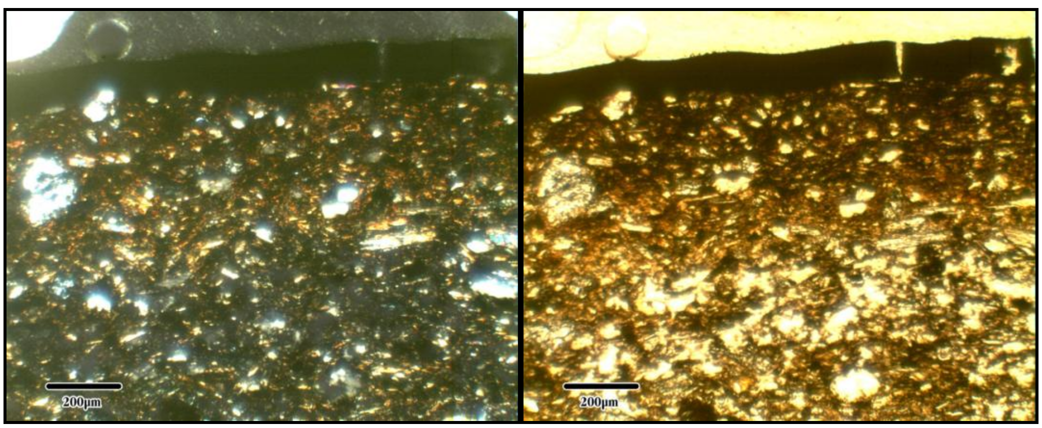



Figure 4.17: Specimen TDD19 with 70 percent to 80 percent temper. The border in the upper part of the photograph shows a thin maroon paint which appears as a dark horizontal layer. Left photograph was taken under normal light; right photograph was taken under polarized light.

Some ceramic specimens show a very dark opague color. For instance, in specimens TDD4, TDD29, TDD173, and TDD174, this dark color is interpreted as the addition of grinded hematite to the temper. All of these specimens show a strong color contrast between the hematite and white temper particles (Groups 1E y 3).

The surface treatment could be analyzed only in some samples, because it is sometimes lost while during the automatic manufacturing of the thin-section. Samples in which surface treatment is observed by the addition of a non-temper slip are TDD4, TDD17, TDD19 and TDD 27 (Figures 4.8, 4.12, 4.16 and 4.17). Moreover, in samples TDD5, TDD15 and TDD172 it is possible to observe the addition of slips which has very small grains of temper.

*Comparative Results between the Petrographic and INAA Analyses*

Principal Component Analysis (PCA) was performed on the 33 chemical elements or variables identified by the INAA study of 360 ceramic, clay, and sediment samples. The results show that only eleven elements have loads greater than 0.2, with the first three accounting for 21 percent of the total variance within the database. Table 4.4 below shows the component weights of the 33 variables obtained from the PCA (numbers in **bold** represent elements with weights greater than 0.2). These same element weights were used in a comparative assessment of the results of both the petrographic and INAA analyses.

| | 10.5 % | 5.3 % | 5.2 % |
|---|---|---|---|
| **VAR** | **PCA1** | **PCA2** | **PCA3** |
| Al | 0.03 | -0.01 | -0.01 |
| **As** | -0.18 | **-0.31** | 0.08 |
| Ba | 0.05 | 0.15 | -0.03 |
| **Ca** | **0.42** | -0.02 | -0.04 |
| Ce | -0.04 | 0.02 | 0.17 |
| Co | 0.01 | -0.06 | 0.20 |
| **Cr** | -0.06 | -0.11 | **-0.32** |
| Cs | 0.02 | 0.00 | -0.05 |
| Dy | 0.04 | 0.04 | -0.03 |
| **Eu** | 0.09 | **-0.37** | 0.14 |
| Fe | 0.02 | -0.01 | -0.00 |
| **Hf** | -0.04 | -0.27 | **0.50** |
| K | 0.03 | 0.00 | -0.00 |
| **La** | -0.04 | -0.02 | **0.26** |
| Lu | -0.02 | 0.06 | 0.09 |
| Mn | -0.09 | 0.07 | 0.15 |
| Na | 0.17 | 0.02 | 0.01 |
| Nd | 0.05 | 0.04 | -0.07 |
| Ni | -0.04 | 0.02 | -0.10 |
| Rb | -0.07 | 0.04 | 0.00 |
| Sb | -0.03 | -0.01 | -0.02 |
| **Sc** | 0.10 | **-0.43** | -0.40 |
| **Sm** | 0.03 | **-0.42** | -0.06 |
| **Sr** | **0.84** | 0.04 | 0.13 |
| Ta | 0.02 | -0.06 | 0.16 |
| Tb | -0.05 | -0.06 | 0.07 |
| Th | 0.03 | 0.15 | 0.16 |
| Ti | -0.01 | 0.01 | -0.01 |
| U | -0.01 | 0.14 | 0.23 |
| V | -0.03 | -0.22 | 0.07 |
| Yb | -0.04 | 0.12 | 0.10 |
| **Zn** | 0.06 | **-0.28** | -0.15 |
| **Zr** | 0.01 | -0.30 | **0.33** |

A second PCA was applied to the eleven selected elements (in **bold**) in Table 4.4. This analysis yielded a weight less than 0.2 for the As element, thus it was eliminated from further consideration. The PCA revealed the three first components accounting for 76.0 percent of the total variance. Table 4.5 below indicates the ten variables with weights greater than 0.2.

| | 34.6 % | 24.9 % | 16.6 % |
|---|---|---|---|
| VAR | PCA1 | PCA2 | PCA3 |
| **Ca** | 0.36 | 0.12 | **-0.43** |
| **Cr** | -0.02 | 0.26 | **0.59** |
| **Eu** | **0.45** | -0.28 | 0.06 |
| **Hf** | -0.19 | **-0.50** | -0.05 |
| **La** | 0.32 | **-0.36** | 0.25 |
| **Sc** | **0.40** | 0.20 | 0.18 |
| **Sm** | **0.43** | -0.30 | 0.23 |
| **Sr** | 0.33 | 0.10 | **-0.53** |
| **Zn** | **0.25** | 0.22 | 0.17 |
| **Zr** | -0.14 | **-0.52** | -0.06 |

The next step analyzed the newly derived 10 INAA elements for the 31 petrographic ceramic specimens with temper (six of the original 37 specimens were duplicates and thus excluded from this step; e.g., samples TDD28 a-d). The following step was a discriminant analysis (DA) of a matrix combining the 31 petrographic specimens and the 10 elements. All granitoid tempers (Groups 1a to 1b in Table 1) were designated as factor or cluster G. Factor or cluster M included metamorphic and quartz tempered groups (Groups 2 and 3 in Table 1). Factor or cluster V represented groups composed of mixed tempers of metamorphic and granitoid or volcanic and metamorphic rocks (i.e., Groups 1E+3 and volcanic +3 in Table 1). Table 4.6 below shows the combined petrographic and INAA elemental data used in the DA. The **bold** letters indicate specimens originally of factor G that were reclassified by DA to factor M.

| sample | numbers | petrog. | class.factor | Ca | Cr | Eu | Hf | La | Sc | Sm | Sr | Zn | Zr |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **TDD001** | 1 | 1C | **G** | 4.2470 | 1.7307 | 0.3239 | 0.9282 | 1.3958 | 1.4134 | 0.7828 | 2.2259 | 1.9213 | 2.2468 |
| **TDD002** | 2 | 1A | G | 4.2700 | 1.8113 | 3.0660 | 0.9821 | 1.3466 | 1.3364 | 0.8046 | 2.3880 | 1.8599 | 2.2766 |
| **TDD003** | 3 | 1C | G | 4.2199 | 1.6388 | 0.3914 | 0.7787 | 1.4594 | 1.4357 | 0.8904 | 2.5604 | 2.0233 | 2.2368 |
| **TDD004** | 4 | 3 | M | 4.3308 | 1.2904 | 0.4284 | 1.1297 | 1.4577 | 1.3294 | 0.8515 | 2.4706 | 1.7921 | 2.5241 |
| **TDD005** | 5 | 1A | G | 4.2798 | 1.6343 | 0.3896 | 0.8242 | 1.4573 | 1.4291 | 0.8859 | 2.4309 | 2.0312 | 2.2109 |
| **TDD006** | 6 | 1E | G | 4.3174 | 1.6483 | 0.4231 | 0.9407 | 1.5429 | 1.3825 | 0.9118 | 2.3396 | 1.9732 | 2.2581 |
| **TDD007** | 7 | 1A | G | 4.2375 | 1.3975 | 0.3273 | 0.8619 | 1.4138 | 1.2117 | 0.7672 | 2.2961 | 1.8309 | 2.1943 |
| **TDD008** | 8 | 1E | G | 4.2072 | 1.6104 | 0.3709 | 0.7876 | 1.4426 | 1.3976 | 0.8374 | 2.3764 | 2.0022 | 2.0912 |
| **TDD009** | 9 | 1A | G | 3.9185 | 1.4765 | 3.1329 | 0.8997 | 1.5960 | 1.2924 | 0.8634 | 2.2778 | 1.9214 | 2.1999 |
| **TDD010** | 10 | 1A | **G** | 3.9828 | 1.3768 | 0.2987 | 0.8588 | 4.2921 | 1.1883 | 0.6908 | 2.4814 | 1.8287 | 2.2222 |
| **TDD012** | 12 | 1B | G | 4.2444 | 1.7898 | 0.3489 | 0.8599 | 1.3515 | 1.3464 | 0.8018 | 2.4297 | 1.8958 | 2.2056 |
| **TDD013** | 13 | 1A | G | 3.9602 | 1.4366 | 0.3465 | 0.8451 | 1.4337 | 1.2506 | 0.7915 | 2.2570 | 1.7803 | 2.1230 |
| **TDD014** | 14 | 2 | M | 4.2936 | 1.8013 | 0.3252 | 0.8989 | 4.2817 | 1.3702 | 0.7717 | 2.3320 | 1.9211 | 2.1910 |
| **TDD015** | 15 | 1A | **G** | 4.1657 | 1.4409 | 0.4134 | 1.1327 | 1.4227 | 1.3726 | 0.8467 | 2.3648 | 1.8812 | 2.4819 |
| **TDD016** | 16 | 1A | **G** | 4.0148 | 1.5794 | 0.3426 | 0.7839 | 1.3698 | 1.4243 | 0.7959 | 2.1755 | 1.9627 | 2.0817 |
| **TDD017** | 17 | 1B | G | 4.5497 | 2.0790 | 0.3519 | 0.7906 | 1.3860 | 1.4380 | 0.7370 | 2.4303 | 4.9556 | 2.0632 |
| **TDD018** | 18 | 1A | G | 3.8958 | 1.3423 | 0.3107 | 0.9034 | 1.4147 | 1.1555 | 0.7295 | 2.3577 | 1.8527 | 2.2484 |
| **TDD019** | 19 | 3 | M | 3.7464 | 1.2987 | 0.2803 | 0.7216 | 1.2858 | 1.3301 | 0.7120 | 2.1450 | 1.8795 | 1.9910 |
| **TDD021** | 21 | 1A y 1E | G | 4.0542 | 1.6215 | 0.3547 | 0.8062 | 1.3909 | 1.4064 | 0.8317 | 2.4436 | 1.9533 | 2.1431 |
| **TDD022** | 22 | 1D | G | 4.2351 | 1.8110 | 0.3338 | 0.9067 | 1.3312 | 1.3557 | 0.7919 | 2.1986 | 1.8916 | 2.1633 |
| **TDD023** | 23 | 1A | G | 3.9960 | 1.3896 | 0.4643 | 0.9255 | 1.5279 | 1.3282 | 0.8717 | 2.2813 | 1.8646 | 2.3307 |
| **TDD024** | 24 | 1A | **G** | 3.9840 | 1.5821 | 0.3627 | 0.7371 | 1.4006 | 1.4440 | 0.8178 | 2.1534 | 2.0058 | 2.1557 |
| **TDD025** | 25 | 1A | **G** | 4.2633 | 1.3155 | 3.1652 | 1.0942 | 4.3485 | 1.2178 | 0.7587 | 2.4779 | 1.7144 | 2.4452 |
| **TDD026** | 26 | 1A | **G** | 4.1282 | 1.5363 | 0.3582 | 1.1013 | 1.3924 | 1.4066 | 0.8549 | 2.2915 | 1.9282 | 2.4599 |
| **TDD027** | 27 | 3 | M | 4.3468 | 1.6798 | 0.3549 | 0.8599 | 1.3620 | 1.4024 | 0.7861 | 2.2708 | 1.9319 | 2.2134 |
| **TDD028** | 28 | 1A | G | 4.0014 | 1.5754 | 0.2509 | 0.8325 | 1.2308 | 1.2385 | 0.6401 | 2.2825 | 1.9384 | 2.1696 |
| **TDD029** | 29 | 1E | **G** | 4.5468 | 1.8792 | 0.3805 | 0.8320 | 1.3377 | 1.4742 | 0.8240 | 2.4157 | 1.9941 | 2.1163 |
| **TDD030** | 30 | 1E | G | 3.8260 | 1.5723 | 0.3073 | 1.0893 | 1.4062 | 1.2897 | 0.7872 | 2.2246 | 1.9277 | 2.4651 |
| **TDD172** | 172 | 1B+3 | V | 3.4550 | 1.6939 | 0.4246 | 0.9189 | 1.5598 | 1.3665 | 0.9374 | 0.0000 | 1.9458 | 2.3122 |
| **TDD173** | 173 | VOLC+3 | V | 4.2548 | 2.8410 | 0.3249 | 0.7501 | 1.1941 | 1.4176 | 0.6984 | 0.0000 | 2.0881 | 1.9807 |
| **TDD174** | 174 | 1B+3 | V | 3.8991 | 2.5328 | 0.3271 | 0.8133 | 1.2339 | 1.3515 | 0.7233 | 0.0000 | 2.0321 | 2.2741 |

The first discriminant function with a P-value less than 0.05 (statistically significant at the 95% level) is: -0.925544*Ca +0.0873198*Cr -.0605403*Eu +1.24249*Hf -0.542485*La +0.263227*Sc -0.296363*Sm +1.54025*Sr -0.172578*Zn -1.41347*Zr

Figure 4.18 shows the distribution of the standardized coefficients of the 10 INAA elements (see Table 4.5), defined by the first and second functions. The fourth and third specimens of the petrographic temper groups predicted by classification factors M and V, respectively, were correctly classified. However, seven specimens of the predicted classification factor G were reclassified to factor M. Figure 4.19 shows the distribution of the 31 samples resulting from the DA.

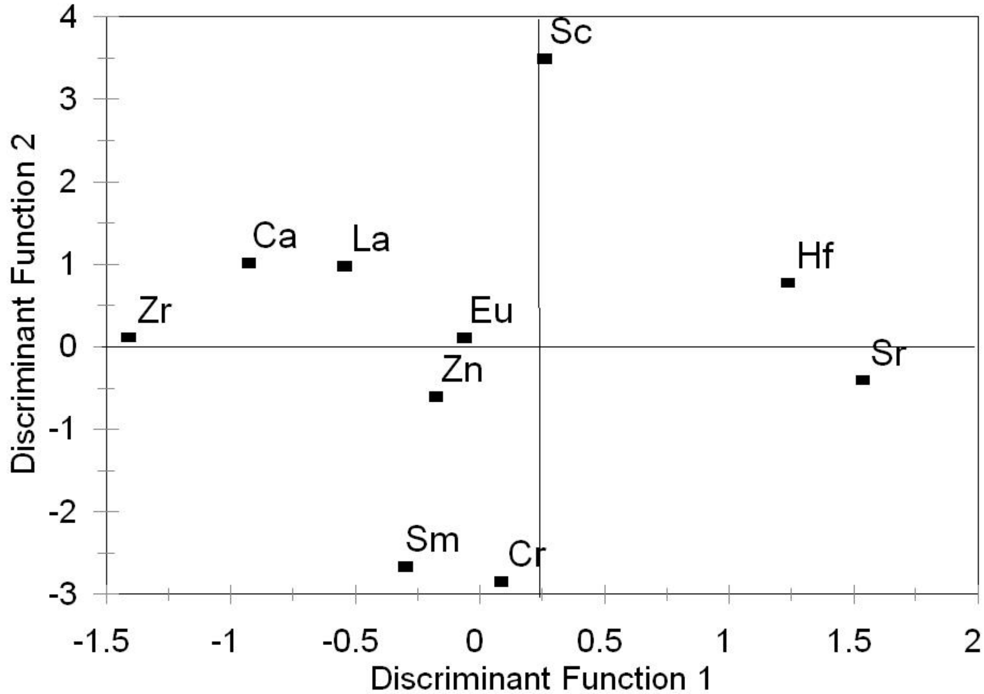



Figure 4.18: Distribution of the standardized coefficients of the 10 INAA elements used in the discriminant analysis.

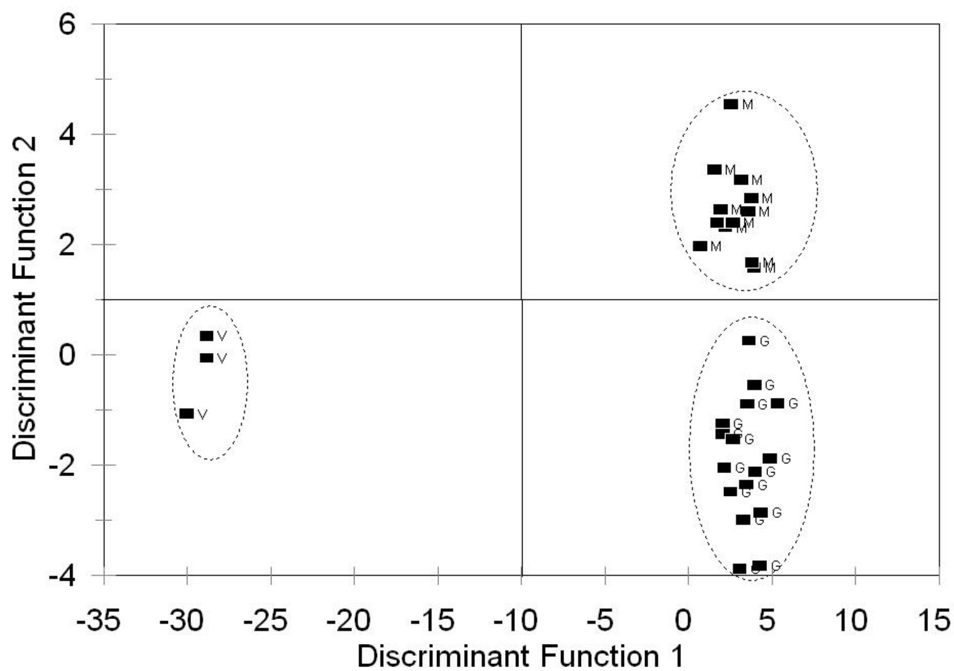



Figure 4.19: Distribution of the discriminant function values of the 31 specimens clustered in the 3 classification factors.

The 3 factor clusters produced by the analysis are clearly discriminated. Both the M and V clusters include specimens of metamorphic rocks and combinations of two different types of rocks, including volcanic components in the latter case, respectively. Some specimens of cluster G were reclassified to cluster M, because the mineralogy and petrology of both the granitoid and schist–phyllite groups are often very similar. The differences between clusters G and M are related to the higher percentages of Ca, Hf, Sc, y Zr in the first cluster, and the higher values of Cr, La, Sr and Zn in the second cluster (Table 4.7). The isolation of cluster V is related to higher values of Cr and Zn, lower values of Ca and Hf, and a value of 0 for Sr (Table 4.7).

Table 4.7 shows the mean values of concentrations of the 10 INAA elements used in the discriminant analysis.

| Classification factor | G | M | V |
|---|---|---|---|
| Counts | 16 | 12 | 3 |
| Ca | 16480 | 15116 | 9586 |
| Cr | 38 | 45 | 360 |
| Eu | 1.28 | 1.28 | 1.30 |
| Hf | 7.9 | 6.7 | 5.8 |
| La | 22.5 | 25.9 | 23.0 |
| Sc | 22.5 | 20.8 | 1.38 |
| Sm | 5.2 | 5.5 | 5.3 |
| Sr | 215 | 227 | 0 |
| Zn | 79 | 83 | 105 |
| Zr | 196 | 166 | 162 |

Lastly, the chemical composition of the 31 petrographic specimens was compared with the chemical composition of 79 INAA clay samples taken from different areas within the Purén and Lumaco Valley, including cultural features in archeological sites and natural clay profiles in stream drainages. The same 10 chemical elements of the former statistical analyses were used. The first step was a PCA of a matrix combining the 79 INAA specimens and the 10 INAA chemical elements (Table 4.8). The results show that the first 2 components explain 90.5 percent of the total variance.

Table 4.8: Chemical data corresponding to the 79 INAA clay samples taken from the Purén and Lumaco Valley.

| sample | Ca | Cr | Eu | Hf | La | Sc | Sm | Sr | Zn | Zr | Factor |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TDD191 | 2.2707 | 1.5853 | 0.2692 | 1.2016 | 1.3432 | 1.0802 | 0.7132 | 0.0000 | 1.7344 | 2.5686 | B |
| TDD192 | 2.7350 | 1.8809 | 0.3125 | 1.0498 | 1.6116 | 1.2919 | 0.8196 | 0.0000 | 1.6343 | 2.4428 | B |
| TDD193 | 2.8859 | 1.7329 | 0.3385 | 1.1000 | 1.4165 | 1.1754 | 0.8125 | 0.0000 | 1.7375 | 2.4867 | B |
| TDD194 | 0.0000 | 1.7117 | 0.2770 | 1.0701 | 1.2791 | 1.0674 | 0.7240 | 0.0000 | 1.6196 | 2.4430 | A |
| TDD195 | 2.9521 | 1.6503 | 0.3154 | 1.0836 | 1.3561 | 1.1116 | 0.7772 | 0.0000 | 1.6795 | 2.4722 | B |
| TDD196 | 2.8347 | 1.6833 | 0.3652 | 1.0868 | 1.5361 | 1.2283 | 0.8648 | 0.0000 | 1.8557 | 2.4521 | B |
| TDD197 | 3.0962 | 1.8231 | 0.2575 | 0.9834 | 1.3326 | 1.2754 | 0.7319 | 0.0000 | 1.7686 | 2.3403 | B |
| TDD198 | 0.0000 | 1.8675 | 0.2776 | 0.9660 | 1.4042 | 1.3545 | 0.7580 | 0.0000 | 1.8729 | 2.3049 | A |
| TDD199 | 3.1967 | 1.8549 | 0.3847 | 0.9323 | 1.4379 | 1.4128 | 0.8709 | 0.0000 | 1.9796 | 2.2058 | B |
| TDD200 | 2.9166 | 1.7761 | 0.2922 | 1.0348 | 1.3300 | 1.1206 | 0.7480 | 0.0000 | 1.6779 | 2.4366 | B |
| TDD201 | 2.6940 | 1.7718 | 0.2286 | 1.1433 | 1.3238 | 1.2001 | 0.6773 | 0.0000 | 1.7961 | 2.4932 | B |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| TDD202 | 2.9464 | 1.7878 | 0.2489 | 0.9726 | 1.3211 | 1.2618 | 0.7062 | 0.0000 | 1.7744 | 2.3245 | B |
| TDD203 | 3.0709 | 1.9336 | 0.2419 | 1.0263 | 1.2379 | 1.1077 | 0.6767 | 0.0000 | 1.7098 | 2.3523 | B |
| TDD204 | 2.5578 | 1.9745 | 0.3360 | 0.9280 | 1.5783 | 1.3781 | 0.8614 | 0.0000 | 1.9216 | 2.3013 | B |
| TDD205 | 2.8747 | 1.7487 | 0.3158 | 1.0469 | 1.3894 | 1.1352 | 0.8007 | 0.0000 | 1.7141 | 2.4212 | B |
| TDD206 | 2.6397 | 1.7051 | 0.3085 | 1.0150 | 1.3835 | 1.1353 | 0.7821 | 1.6828 | 1.7317 | 2.2925 | C |
| TDD207 | 2.9059 | 1.5702 | 0.2554 | 1.1686 | 1.3239 | 1.0649 | 0.6960 | 0.0000 | 1.7391 | 2.5160 | B |
| TDD208 | 2.6100 | 1.8664 | 0.2335 | 1.0223 | 1.4562 | 1.2619 | 0.6814 | 0.0000 | 1.8359 | 2.3884 | B |
| TDD209 | 2.9612 | 1.5385 | 0.2698 | 1.1620 | 1.3521 | 1.0822 | 0.7129 | 0.0000 | 1.7300 | 2.5436 | B |
| TDD210 | 2.8800 | 1.7794 | 0.2014 | 0.9797 | 1.2074 | 1.1603 | 0.6087 | 0.0000 | 1.6802 | 2.3186 | B |
| TDD211 | 0.0000 | 1.6695 | 0.2326 | 1.0048 | 1.2009 | 1.2084 | 0.6556 | 0.0000 | 1.7435 | 2.3425 | A |
| TDD212 | 2.9768 | 1.6238 | 0.3773 | 1.1631 | 1.4905 | 1.1682 | 0.8737 | 0.0000 | 1.7875 | 2.5395 | B |
| TDD213 | 0.0000 | 1.6006 | 0.2810 | 1.1505 | 1.3527 | 1.0895 | 0.7430 | 0.0000 | 1.6992 | 2.5287 | A |
| TDD214 | 0.0000 | 1.6731 | 0.3031 | 1.1074 | 1.3475 | 1.1331 | 0.7610 | 0.0000 | 1.6938 | 2.4667 | A |
| TDD215 | 2.6366 | 1.7502 | 0.2451 | 1.1320 | 1.3039 | 1.1992 | 0.7051 | 0.0000 | 1.7563 | 2.4893 | B |
| TDD216 | 2.2808 | 1.9675 | 0.3286 | 0.9463 | 1.5768 | 1.3860 | 0.8503 | 0.0000 | 1.8315 | 2.3228 | B |
| TDD217 | 2.9248 | 1.6977 | 0.2442 | 1.0899 | 1.2656 | 1.1819 | 0.6769 | 0.0000 | 1.7350 | 2.4586 | B |
| TDD218 | 2.7256 | 1.8677 | 0.2392 | 1.0680 | 1.4710 | 1.2634 | 0.7068 | 0.0000 | 1.8550 | 2.4687 | B |
| TDD219 | 2.6346 | 1.9259 | 0.2870 | 0.9303 | 1.4722 | 1.3766 | 0.7735 | 0.0000 | 1.8641 | 2.1577 | B |
| TDD220 | 3.0683 | 1.5961 | 0.2047 | 1.1759 | 1.2267 | 0.9838 | 0.6265 | 0.0000 | 1.6347 | 2.5385 | B |
| TDD221 | 2.4180 | 1.6146 | 0.2050 | 1.1029 | 1.1788 | 1.1313 | 0.6073 | 0.0000 | 1.6808 | 2.4798 | B |
| TDD222 | 2.7519 | 1.5132 | 0.2409 | 1.1130 | 1.2918 | 1.0089 | 0.6637 | 0.0000 | 1.6777 | 2.5172 | B |
| TDD223 | 2.8919 | 1.5745 | 0.2464 | 1.1632 | 1.3150 | 1.0687 | 0.6922 | 0.0000 | 1.7443 | 2.5111 | B |
| TDD224 | 0.0000 | 1.9624 | 0.2418 | 0.9700 | 1.1646 | 1.2966 | 0.6756 | 0.0000 | 1.8028 | 2.2538 | A |
| TDD225 | 2.7453 | 1.6849 | 0.2338 | 1.1345 | 1.2426 | 1.1664 | 0.6659 | 0.0000 | 1.8092 | 2.4963 | B |
| TDD226 | 0.0000 | 1.9312 | 0.2660 | 0.9838 | 1.4489 | 1.3264 | 0.7666 | 0.0000 | 2.0227 | 2.3378 | A |
| TDD227 | 2.2478 | 1.9170 | 0.3134 | 1.0034 | 1.5812 | 1.3189 | 0.8080 | 0.0000 | 2.0567 | 2.3754 | B |
| TDD228 | 3.2903 | 1.8548 | 0.3596 | 1.0452 | 1.4763 | 1.3046 | 0.8688 | 1.9105 | 2.0182 | 2.4500 | C |
| TDD229 | 3.3015 | 1.8098 | 0.3273 | 1.0328 | 1.4556 | 1.2528 | 0.8379 | 1.6647 | 2.0089 | 2.4050 | C |
| TDD230 | 3.0792 | 2.0245 | 0.4372 | 0.9734 | 1.8013 | 1.4541 | 1.0085 | 0.0000 | 1.7275 | 2.3021 | B |
| TDD231 | 2.9408 | 1.7776 | 0.3768 | 1.0853 | 1.5532 | 1.2386 | 0.9073 | 1.9058 | 1.9180 | 2.4842 | C |
| TDD232 | 3.3873 | 1.9625 | 0.4411 | 0.8337 | 1.6715 | 1.4418 | 0.9938 | 0.0000 | 2.1369 | 2.1037 | B |
| TDD233 | 4.2129 | 1.7634 | 0.4585 | 1.0203 | 1.6377 | 1.4224 | 0.9889 | 2.1588 | 2.1195 | 2.3385 | C |
| TDD234 | 3.1117 | 1.6458 | 0.2567 | 1.0567 | 1.3279 | 1.0831 | 0.7198 | 0.0000 | 1.8059 | 2.4268 | B |
| TDD235 | 3.3340 | 1.5335 | 0.2377 | 0.8235 | 1.2366 | 0.9742 | 0.6455 | 1.6426 | 1.7216 | 2.1050 | C |
| TDD236 | 3.4039 | 1.9500 | 0.4630 | 0.7778 | 1.6784 | 1.4579 | 1.0041 | 0.0000 | 2.1261 | 2.0900 | B |
| TDD237 | 3.5600 | 1.8722 | 0.4870 | 0.7936 | 1.6899 | 1.4529 | 1.0295 | 0.0000 | 2.1037 | 2.0364 | B |
| TDD238 | 3.5158 | 1.7647 | 0.4475 | 0.9809 | 1.6236 | 1.3256 | 0.9822 | 0.0000 | 1.9315 | 2.3277 | B |
| TDD239 | 3.0220 | 1.8106 | 0.3339 | 1.0627 | 1.4871 | 1.3010 | 0.8535 | 0.0000 | 1.8642 | 2.3494 | B |
| TDD240 | 3.6656 | 1.8569 | 0.5699 | 0.7122 | 1.7643 | 1.4785 | 1.1275 | 0.0000 | 2.2685 | 2.1519 | B |
| TDD241 | 4.0084 | 1.7721 | 0.5828 | 0.9077 | 1.8666 | 1.4229 | 1.1452 | 1.8654 | 2.0607 | 2.2149 | C |
| TDD242 | 4.0914 | 1.7409 | 0.3253 | 1.0618 | 1.4508 | 1.3553 | 0.8151 | 1.9966 | 1.9427 | 2.3665 | C |
| TDD243 | 3.7547 | 1.9270 | 0.5418 | 0.6486 | 1.7801 | 1.5210 | 1.1044 | 0.0000 | 2.1935 | 2.0915 | B |
| TDD244 | 3.1089 | 1.6905 | 0.3249 | 1.0866 | 1.3500 | 1.2118 | 0.7936 | 0.0000 | 1.7520 | 2.3873 | B |
| TDD245 | 3.0589 | 1.7195 | 0.3312 | 1.0539 | 1.4194 | 1.1328 | 0.8173 | 0.0000 | 1.7375 | 2.3625 | B |
| TDD246 | 3.1357 | 1.6923 | 0.3358 | 1.0395 | 1.4294 | 1.0882 | 0.8206 | 0.0000 | 1.6321 | 2.3847 | B |
| TDD247 | 3.9486 | 1.9551 | 0.3978 | 1.0594 | 1.5668 | 1.1678 | 0.8886 | 2.1828 | 1.7232 | 2.4262 | C |
| TDD248 | 3.3422 | 2.0298 | 0.4830 | 0.8428 | 1.8127 | 1.4579 | 1.0875 | 0.0000 | 0.0000 | 2.0651 | B |
| TDD249 | 3.3371 | 1.9684 | 0.4810 | 0.9132 | 1.7594 | 1.3945 | 1.0713 | 0.0000 | 2.0006 | 2.2449 | B |
| TDD250 | 3.0936 | 1.6048 | 0.3039 | 1.0790 | 1.3498 | 1.2126 | 0.7614 | 0.0000 | 1.7664 | 2.4018 | B |
| TDD251 | 2.4142 | 1.7453 | 0.3541 | 0.9887 | 1.3439 | 1.3791 | 0.8216 | 0.0000 | 2.1730 | 2.3018 | B |
| TDD252 | 3.5199 | 1.6257 | 0.3310 | 1.1134 | 1.4480 | 1.1057 | 0.8298 | 1.9454 | 1.8188 | 2.4301 | C |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| TDD253 | 2.6990 | 1.6929 | 0.2648 | 1.0913 | 1.3336 | 1.2138 | 0.7144 | 0.0000 | 1.7673 | 2.3850 | B |
| TDD254 | 3.1850 | 2.0351 | 0.4651 | 0.8865 | 1.7755 | 1.4496 | 1.0638 | 1.5533 | 2.0678 | 2.2230 | C |
| TDD255 | 2.4100 | 1.8951 | 0.2787 | 1.0401 | 1.4877 | 1.2910 | 0.7892 | 0.0000 | 1.9556 | 2.3572 | B |
| TDD256 | 2.9864 | 1.5547 | 0.2292 | 1.2106 | 1.2550 | 1.0359 | 0.6652 | 0.0000 | 1.6275 | 2.5443 | B |
| TDD257 | 3.4638 | 1.8044 | 0.4179 | 1.0290 | 1.5485 | 1.3788 | 0.9466 | 0.0000 | 1.9590 | 2.3076 | B |
| TDD258 | 3.0179 | 1.6229 | 0.3189 | 1.1332 | 1.4164 | 1.1669 | 0.7919 | 0.0000 | 1.7709 | 2.4648 | B |
| TDD259 | 0.0000 | 1.6582 | 0.4111 | 1.1491 | 1.5120 | 1.2743 | 0.9107 | 0.0000 | 1.8384 | 2.5244 | A |
| TDD266 | 3.1885 | 1.8438 | 0.3657 | 1.1032 | 1.4888 | 1.4063 | 0.8585 | 0.0000 | 1.9880 | 2.3914 | B |
| TDD324 | 3.5014 | 1.5362 | 0.3685 | 1.0803 | 1.4716 | 1.1077 | 0.8649 | 0.0000 | 1.6665 | 2.4191 | B |
| TDD325 | 3.0105 | 1.6654 | 0.2658 | 1.0716 | 1.2894 | 1.2667 | 0.7136 | 0.0000 | 1.7972 | 2.4512 | B |
| TDD326 | 4.1196 | 1.7188 | 0.4529 | 0.8998 | 1.6191 | 1.4222 | 0.9528 | 1.9739 | 2.0243 | 2.2434 | C |
| TDD327 | 2.9066 | 1.6648 | 0.3485 | 0.9502 | 1.4687 | 1.3473 | 0.8112 | 0.0000 | 1.9462 | 2.2728 | B |
| TDD328 | 2.6989 | 1.5593 | 0.2956 | 1.0029 | 1.3371 | 1.1558 | 0.7182 | 0.0000 | 1.7289 | 2.3984 | B |
| TDD329 | 2.9925 | 1.6799 | 0.3051 | 1.0527 | 1.3528 | 1.1389 | 0.7502 | 1.3764 | 1.7500 | 2.3792 | C |
| TDD330 | 0.0000 | 1.8883 | 0.3229 | 0.9139 | 1.3590 | 1.2171 | 0.7714 | 0.0000 | 1.9180 | 2.1550 | A |
| TDD331 | 3.4379 | 1.7926 | 0.3826 | 1.0402 | 1.4900 | 1.2318 | 0.8789 | 0.0000 | 1.8121 | 2.3911 | B |
| TDD332 | 2.2717 | 1.8025 | 0.2412 | 1.0376 | 1.3098 | 1.2536 | 0.6788 | 0.0000 | 1.7657 | 2.3283 | B |

Three types were clearly defined, A, B and C, and used as discrimination factors for all clay data (Table 4.8). Two significant discrimination functions were also obtained. The clay data were then plotted on a plane created by the two functions (see Figure 4.19). Finally, the chemical data of the 31 petrographic ceramic specimens were entered into the discriminant model to calculate a new classification. Figure 4.20 shows the composition distribution of clay Types A, B and C, with one specimen of cluster V (TDD172) appearing with Type B. (However, none of the cluster V are chemically related to any of the other 30 specimens of the petrographic collection). Most of the 30 specimens are affiliated with Type C clays. However, there are a few specimens that differ in chemical composition from those in the three clay groups of the Purén and Lumaco Valley: TDD 2, TDD9, TDD10, TDD14 and TDD25 of temper cluster G and cluster M and specimens TDD173 and TDD174 of temper cluster V.

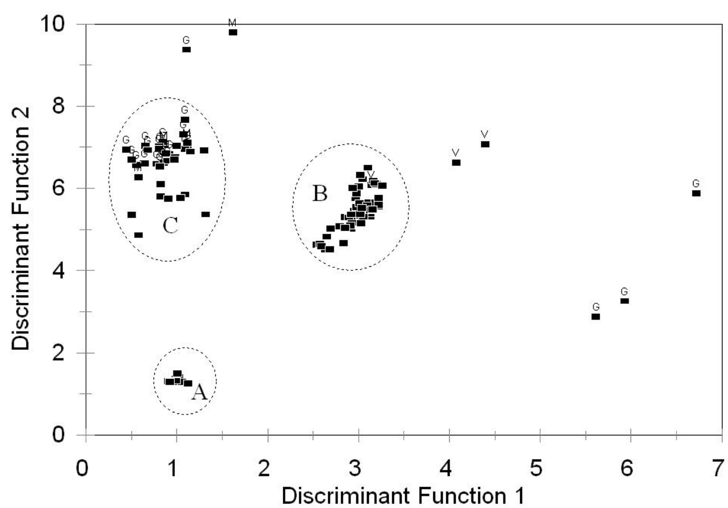



Figure 4.20: Distribution of the discriminant function values of the 79 clay samples classified in Types A, B and C and the 31 ceramic specimens of petrographic clusters G, M and V.

Table 4.9 shows the chemical mean values of clay types A (n=9), B (n= 59) and C (n=14) and of the ceramic specimens TDD2, TDD9, TDD10, TDD14, TDD25, TDD173 and TDD174, with the latter not associated with any clay types. Clay Type A is characterized by the absence of Ca and Sr and lower concentrations of Eu, La, Sc, Sm and Zn. In Type B, the mean values are intermediate between Type A and Type C, with the exception of Sr, Hf and Zr. Type C is characterized by the highest concentrations of Ca, La, Sc, Sm and Zn. The seven ceramic specimens that do not belong to any clay groups have concentrations of Ca over 7900. Specimens of cluster V (TTD173 y TDD174) also have the highest concentrations of Cr, Sc and Zn, and the lowest concentrations of La. In these two specimens, Sr is not present. Five other specimens belong to clusters G and M, which have higher concentrations of Ca and Sr in relation to other clay types.

Table 4.9: Chemical composition of clay types (mean values) and of ceramic specimens not included in any clay types.

| Type | Ca | Cr | Eu | Hf | La | Sc | Sm | Sr | Zn | Zr |
|---|---|---|---|---|---|---|---|---|---|---|
| TDD002 | 18618 | 64 | 1.2 | 8.6 | 21 | 21 | 5.4 | 243 | 71 | 188 |
| TDD009 | 8289 | 29 | 1.4 | 6.9 | 38 | 19 | 6.3 | 189 | 82 | 157 |
| TDD025 | 18337 | 20 | 1.5 | 11.4 | 22 | 16 | 4.7 | 300 | 51 | 278 |
| TDD010 | 9610 | 23 | 1.0 | 6.2 | 20 | 14 | 3.9 | 302 | 66 | 166 |
| TDD014 | 19660 | 62 | 1.1 | 6.9 | 19 | 22 | 4.9 | 214 | 82 | 154 |
| TDD173 | 17980 | 692 | 1.1 | 4.6 | 15 | 25 | 4.0 | 0 | 121 | 95 |
| TDD174 | 7926 | 340 | 1.1 | 5.5 | 16 | 21 | 4.3 | 0 | 107 | 187 |
| CLAY TYPE A | 0 | 61 | 1.0 | 10.0 | 22 | 16 | 4.7 | 0 | 65 | 244 |
| CLAY TYPE B | 1249 | 60 | 1.1 | 10.0 | 29 | 17 | 5.7 | 0 | 70 | 244 |
| CLAY TYPE C | 5704 | 60 | 1.4 | 9.2 | 35 | 18 | 7.0 | 77 | 86 | 222 |

*Conclusions*

The analyzed thin sections indicate that the majority of the temper was obtained from weathered rocks located as outcrops or as pebbles and cobbles in the creek and river beds or point bars. Only a small portion was derived from fluvial sands. Temper in ceramics range widely from 20 percent to 80 percent of the paste composition, with most having 30 percent to 70 percent. The degree of temper rounding was not conclusive to separate types, with the exception of specimen TDD14, which was comprised exclusively of ground and highly angular quartz particles.

The description of the mineralogy of the Traiguen and Nahuelbuta plutons (Hervé 1977; SERNAGEOMIN 2003) is not detailed enough to permit the exact identification of tempers. Nonetheless, the degree of rounding and the composition of specimens of Groups 1A y 1B seem to correspond to the Traiguen pluton.

The large area of the biotite rich granitoid plutons is not detected proportionally in the temper, observed only in samples TDD17 and TDD12. There are no specimens where epidote is a principal constituent of the dark minerals, so Groups 1C and 1D appear to be allochthonous to the Purén and Lumaco Valley. Syenite is described in the available literature of the Nahuelbuta pluton (Hervé 1977; SERNAGEOMIN 2003); it is regarded as a local source in samples TDD6, TDD8, TDD21a, TDD29 and TDD30. The quartz is available as veins in both plutons and in the metamorphic local rocks. Finally, more than half of the two side walls of the Purén and Lumaco Valley are covered by metamorphic phyllites, which are recorded as fragments in the temper of only six samples (TDD4, TDD19, TDD27, TDD172, TDD173 and TDD174). Only 4 samples (TDD4, TDD9, TDD10 and TDD15) were identified as having temper made of sand or due to its low degree of weathering and rounding. The last variable is also common to temper taken from a regolith. Finally, the presence of fragments of andesite in the temper of sample TDD173 is direct proof of an Andean source, because the fluvial watershed systems and source elements in the Purén and Lumaco Valley are derived from the coastal mountain range. In this case, it should be noted that an allochthonous source is mixed with local metamorphic rocks. Those ceramics with temper of volcanic ash also are exotic to the study area.

Results of principal component multivariate and discriminant clustering analyses are frequently used in the interpretation of chemical data (INAA) showing internal heterogeneity (Druc 2004). However, Stoltman et al. (2005) point out that INAA analysis relying on only chemical elements has important limitations in identifying non-local pottery within large data sets. INAA fails to identify chemical communalities in the composition of minerals and ceramic tempers. Petrographic analysis of ceramics must also be employed to offset this limitation. The present study followed this recommendation first by analyzing the petrographic composition of ceramic specimens to obtain statistically reliable groupings. Once this was achieved, ten significant chemical elements of the INAA data were compared with the groupings. The result was that a few ceramics contained a mixture of two types of rocks (cluster or factor V). One was an exotic source with volcanic ash from the Andean mountains to the east. This source has a completely different chemical signature from local ones in the Purén and Lumaco Valley. Cluster V ceramics also have a dark hematite temper, which is an exotic or allochthonous type. The next step was to apply the results of the INAA to a large collection of clay samples taken from the Purén and Lumaco Valley. A discriminant function model was produced that recognized 3 robust types of clay represented by the 31 petrographic specimens. This approach revealed two clay types in the Purén and Lumaco Valley (A and B) that are related to chemical signatures recognized in the petrographic study of ceramics, with the exception of one sample in Cluster V (TDD172). Although most specimens in clusters G and M are affiliated with clay Type C, some specimens are not chemically related to any known clay sources in the valley. These are the specimens with volcanic Andean components (e.g., TDD173).

## Chapter 5: Temporal Ceramic Patterns

Tom D. Dillehay

### *Introduction*

In this chapter, attribute trends observed within the total or inter-site ceramic assemblage are first discussed, with an emphasis on the refinement of the ceramic chronology and variability within the Purén-Lumaco collection. These are followed by a brief overview of how ceramic attributes from stratigraphic excavations co-occur, principally in the site type of PU-165. Temporal trends in attributes are followed by a discussion of inter-site patterns in ceramics related to the period before and during contact with the Spanish in the region.

### *Broad Temporal Trends in the Ceramic Types*

The PU-165 excavations exposed the Preceramic through Early Hispanic occupational sequence of the site. Therefore, this site anchors the beginning and ending points of the ceramic temporal sequence, and permits the EPH, LPH and EH occupations, observed in nearly all excavations, to be situated within a long history of site development and change. Other sites important to the characterization of temporal trends are PU-122, PU-132, PU-157, and PU-166 but to a lesser extent than PU-165.

In this discussion, particular attention is paid to broad trends in paste categories, vessel forms, and surface treatment techniques and types, including decorations using motifs. Since there are no detailed studies of ceramic paste types in south-central Chile, it is difficult to show whether they were stable over time, or changed gradually, especially compared to surface treatments that are more apt to be manipulated by social actors. The exceptional instances where rapid paste changes occurred could reflect 1) shifts in the economic or other factors that impacted the networks that provisioned particular raw materials, 2) sustained interactions (including co-residency) with groups using different ceramic traditions, 3) recruitment of, colonization by, and/or annexation of outside indigenous groups, or 4) contact with the Spanish. More fleeting expressions of identity and change in ceramic styles might have been frequently manipulated in the Araucanian/Spanish frontier zone south of the Río Bío Bío during the $16^{th}$ through $18^{th}$ centuries, with groups making use of decorative treatments that conveyed important social and political messages.

Briefly, four distinct occupations at PU-165 were identified on the basis of stratigraphy and radiocarbon dating. The earliest observed occupation of PU-165 predated the ceramic period and occurred during the middle to late preceramic period (~5000-1500 BP). Comparisons of stratigraphic position and radiocarbon dating suggested that the basal deposits in block and trench excavations in PU-165, PU-166, and LU-69 represent this early occupation.

The EPH period is superimposed directly on the preceramic deposits. It is represented primarily by the Pitrén style and by non-dianostic plainwares. The dating of this period is extrapolated from various sites (LU-69, PU-165, PU-166) that yielded Pitrén type ceramics through LPH dates, suggesting similar dates for other prehispanic strata in other sites. Preceramic and Pitrén deposits were excavated in very few sites across the study area. Based partly on similar changing frequencies of ceramic assemblages at these sites, the occupation that immediately followed Pitrén in all areas extended from the later portion of the Pitrén sequence to the early El Vergel period and lasted through the EH period (~AD 1200-1550/1600). On this basis, and for ease of discussion, we discuss all site deposits immediately predating the LPH period as a single Prehispanic unit. The beginning of the El Vergel period has been pushed back to roughly the eleventh century AD (e.g., Aldunate 1989; Dillehay 1990 a, b), therefore, bringing the valley in line temporally with areas such as the south-central valley (c.f., Gaeta and Sánchez 1995), the Lake District (Navarro and Adán 1999; Adán and Mera 1997; Adán and Alavarado 1999), and the coast of Arauco (Quiroz 2001, 2008).

The EPH is roughly contemporaneous with the Pitrén period identified at PU-122, PU-165, and PU-166, where it was assigned to ~AD 500-1100/1200. Because the dating of this period is based on radiocarbon and TL dates, and because the dates obtained from Pitrén deposits at PU-165 date to the middle of the 7$^{th}$ century AD, we use the AD 550-1100/1200 date range for the Pitrén period at this site. The small Pitrén period assemblage at PU-165 has different relative frequencies of particular ceramic pastes than the comparable El Vergel deposits at PU-122 and PU-165, but the PU-165 assemblage is characterized by serving jars and a few large urn vessels, suggesting the differences between the two site assemblages might relate primarily to site area functions and probably to sampling bias, in addition to temporal and functional differences, with PU-165 being better represented by a larger excavation area. The LPH at PU-165 corresponds with the El Vergel period at PU-122, which begins at AD 1100/1200 or slightly before and extends to perhaps AD 1550/1600.

During the terminal LPH and EH periods (~AD 1500-1700), there is an inverse trend in the frequency of several ceramic types and an increase in the variability and quantity of other types, including hybrid forms and exotic wares. The surface collected and excavated deposits from all sites yielded more than 13,500 sherds, including rim and body sherds and vessel components (e.g., handles, bases); nearly 85 percent (n=281) of rims came from PU-165, owing to the more extensive areas of excavation in this locality and to deeper occupational deposits. Of the ceramic total, 22.2 percent (3,001) of the sherds were associated with the EH. Not only do the LPH and EH periods of settlement at PU-165 and other sites account for the majority of materials recovered from excavations, but it represents a moderate increase (55.4 percent) in sherd frequency from the previous period. Further, the late levels at these sites contained all types, especially Types 1, 2, 3, and 11, while fewer types were found in the EPH and lower LPH levels. Based on inclining sherd frequencies and type varieties at these sites, we suggest that a major population change occurred—one related to an influx of both local and different paste, temper, and ceramic types probably caused by the movement of more local (<10-25 km radius) and distant (>30 km radius) populations to these sites and to the valley in general. The close proximity (<5 km radius) of sites PU-165, PU-122, and PU-132, all with similar ceramic patterns, suggests that they may have closely affiliated in kinship terms and received related external groups during the LPH and EH periods. The EH is also the period when population increases began to be highly visible in the settlement pattern of the valley as well (Dillehay and Sáavedra 2010). Furthermore, the only stylistically exotic sherd types recovered from excavations were dated to the terminal LPH and EH levels at sites PU-35 (n=3), PU-122 (n=8), and PU-165 (n=18).

These are usually plainware sherds of an exotic paste or temper types (see Chapter 3), maroon slipped, Valdivia type ceramics, and Spanish porcelain wares and glazed wares.

*Site Trends in Ceramic Pastes*

During the LPH period, granite tempered pastes, followed by medium feldspar, fine quartz, mica schist, and untempered, were best represented in this assemblage. By the subsequent EH period, a slight increase in the frequency of sherds had occurred. Tempered and untempered orange pastes continued to be the most commonly used at PU-165, and considerable quantities of light to medium dark graywares were also recovered, but the other pastes that were common during the EPH declined in frequencies. On the other hand, medium granite particles, quartz, mica, and coarse quartz became more common during the LPH and EH periods. While EH ceramics account for a slightly smaller percentage of the assemblage from excavations than LPH materials, they still represent a sizeable component.

With regard to pastes, those used most during the LPH period continued during the EH period with mostly minor fluctuations. EH settlement represented a boom in both the extent of settlement at PU-165, but also in variety and, in some sites, abundance of materials. With the increase in assemblage size from the LPH period to the EH period, there also was an increase in the number of paste gradations that were represented. Perhaps the most marked change reflected in the examination of paste temper size and type is the decrease in fine to medium quartz tempered pastes and their replacement by medium to coarse temper. This decline in fine to medium tempered pastes stands out especially against the comparatively increased proportions of medium and coarse tempered ceramics. In contrast to mainly mixed sized quartz tempers, pastes having primarily quartz temper experienced different changes. Fine and medium quartz tempers also exhibit parallel trends even though fine to medium tempered pastes account for a larger percentage of assemblage sherds than coarse tempered ceramics in both the LPH and EH. The relative frequencies of medium to coarse tempered sherds peak during the EH period. Ceramics with medium and coarse temper also experienced changing relative frequencies that in each period reflected the opposite trend seen in the fine and medium quartz assemblages. In other words, as the relative frequencies of fine and medium tempered sherds declined from the LPH to the EH, medium and coarse tempered sherds increased. Also, as fine and medium tempered ceramics decreased over the course of site occupation, coarse tempered sherds increased until their relative frequency converged with those of fine and medium quartz tempered ceramics.

*Ceramic Vessel Forms, Rims, and Lips*

<u>Early Hispanic Period (EH), Levels 1-2 (0-30 cm):</u> Sherds recovered from the upper levels of excavation blocks and pits in PU-165 were generally more poorly fired and with surfaces more heavily eroded. These levels also contained more incised, punctated, and red and orange slipped sherds. Handles are also a much more prevalent feature in these upper levels, especially flat handles. Most late rims are generally small, with tapered and round lips. Sherd sizes are also smaller than other levels, but this is explained by the upper levels perhaps having been exposed to more intense occupation. The greatest variation of types and varieties also are found in the

upper levels. Nearly all types are found in these levels, but types 1, 2, 6, and 11B are most prevalent. Rims are more everted and lips are more tapered in last level.

Sherds with parallel lines of punctated dots, incised lines, red and orange slips, and/or incisions primarily occur in levels 1 and 2. Punctated designs and incisions appear mainly on Type 2 and varieties 11A and 11B in these levels. Less neckless jars with thick, round to widely tapered rims are present in the upper levels. To a greater extent are sherds with tapered lips on short and long slightly necked jars. Necked jars with short and medium everted necks and wide orifices are most represented by Type 9. Thinly tapered lips also found on sherds of types 2 and 9.

In sum, EH period forms saw changes in the proportions of a few vessel form categories. There is a slight increase in drinking vessels and shallow serving bowls and plates. Medium and coarse granites and quartz tempered orange, coarse quartz tempered orange, and untempered gray pastes are well represented in the period assemblage. Vertical and straight, vertical and convex, and outsloping walls mainly characterize the assemblage, but other forms are also present. Lip forms are especially diverse during the EH, but four are particularly common on vessels: rounded, abrupt angle, flat, and particularly tapered.

Small to medium size necked jar forms account for ~77.0 percent of the EH rim assemblage. Necked jars were probably used in utilitarian functions related to the preparation and storage of food. These jars also may have been important in cargo transport as well. Necked jars were typically made with coarse tempered pastes (75 percent), with no apparent preference in temper types as granite, mica, quartz, and muscovite aplastic minerals were all used. Like during the LPH period, necked jars often had divergent and curved divergent necks. Lips on necked jars were often direct, symmetrical and rounded or diverted and curved.

Late Prehispanic Period (LPH), Levels 2-4 (15-60 cm*):* Red and orange slips and incised lines chronologically first appear in level 3, but in lower frequencies and increase in levels 1 and 2. Rims are generally more tapered and a few handles are present. Most wares are similar to those in level 1. Everted rims predominate also. Over time, the relative frequencies of drinking vessels and shallow bowls and plates increase slightly as jars increase moderately.

These levels are where Variety 11B chronologically begins to dominate, and to a lesser extent, types 2 and 6. Rims are generally longer and straighter; some tapering occurs but less sharply than those in levels 1 and upper level 2. Neckless jars and fewer everted rims also occur. Tapered and thicker rims also characterize these levels.

Types 6 and 9 dominate in level 4. There are not as many smoothed and well-smoothed sherds in level 4; many of these sherds have micro-pits on their exterior surfaces due to erosion or oxidized inclusions.

In sum, the LPH vessel forms in levels 2-4 contained mostly necked jars (84.3 percent). A few large urns and small bowl rims were also identified, but they account for much smaller portions of the assemblage than jars. Small neckless jars were also important during this period. Untempered and granite tempered pastes characterize a small portion of the bowl assemblage, and most were types 2 and 11 and Variety 11A. Frequently used pastes included fine to medium granite, quartz, and mica schist tempers. Most remaining sherds had medium size temper made of granite and schist particles. Few vessels were made from coarse tempered pastes and granite appears to have been preferred. Everted concave and straight walled jars were the most common shapes in this period, and there were also a few everted convex walled jars forms.

Lips on jars were variable, but two types were most commonly used: rounded and tapered. Larger vessel size, estimated by orifice diameter, suggests that more people were fed by the forms found in level 2. Partly because of low sample size, there does not appear to be a correlation between vessel orifice diameter and paste recipe (i.e., larger jars are not necessarily made of coarser pastes). The paste used is probably more related to the more general functional category (e.g., serving versus cooking) of the vessel.

Of the 81 necked jar rims recovered from LPH period deposits of PU-165, 82.7 percent were made from fine to medium tempered pastes and most of these were made using mixed quartz and granite tempers. Medium tempered necked jars are also mainly made from granite, quartz, and mica tempered pastes. Finally, some necked jars were untempered or had fine to medium temper, which had fewer jars.

Vertical necks and necks with everted or outflaring rims best characterize the identified necked jar forms. The outflaring necked jars did not have a distinct break between the neck and jar body. Lip form, like the pastes used in necked jars, was spatially variable. Lip form was not always recordable but when it was, rounded and then tapered were the most common forms in PU-165. A variety of tempered and untempered pastes, as well as wall and lip shapes were used in the production of jars and drinking vessels. Drinking vessels are small mugs (n=2) with straight rims and handles placed directly on the rim and lip. The few shallow bowls (n=3) of the LPH period had outsloping convex walls. Lip forms on bowls were variable, but the most frequent type was rounded rim. Orifice diameters were also variable site wide, ranging from 10 to 36 cm, but the majority measured about 7 to 10 cm.

<u>Early Prehispanic Period (EPH), Levels 5-7 (60-105 cm):</u> The sherds from these deeper levels are generally better made than those in the upper levels. Thinner walls appear in the major types and varieties (2, 5, 11B) and the interior and exterior surfaces are well-smoothed. Several different rim forms are both short and long everted. Varieties 11A and 11B are most prevalent. Type 6 is more dominate than Type 9. A higher frequency of small to medium size neckless jars and sherds with everted and tapered rims are found in level 5 and to a lesser extent level 6.

Fewer rims were recovered from the basal levels. Most rims are incurvated, representing different sizes of neckless and necked jars with restricted orifices. Types 2, 9 and 10 and Variety 11A are most prevalent.

In sum, the EPH (Pitrén) vessel forms recovered from sites, early rim sherds from levels 5-7 in excavated sites were low. Nevertheless, the main forms represented are short to medium necked jars with everted rims and rounded to slightly tapered lips. Most necked jars were made from medium or coarse pastes, half of which had mixed granites, muscovites, mica, and quartz temper jar forms had predominantly divergent and curved divergent necks. EPH necked jar orifice diameters ranged from 8 to 12 cm. To a lesser extent, the EPH vessel form also was a medium size neckless jars; its relative frequency declines from the EH to LPH periods, and the number of necked jars increases. The relative frequencies of most other forms remain similar from the EPH period to the LPH period, although drinking vessels (n=4) and shallow bowls (n=3) increase through time. Bases are minimal in number and represent slightly rounded to flat surfaces. The sample size was too small to distinguish changes from the early to the late periods of this period.

Urns were infrequent in the total assemblage, constituting about 2.2 percent of the EPH, 6.3 percent of the LPH, and 5.7 percent of the EH ceramics. None of the urn fragments showed any painting, although 2 sherds of the LPH and 4 of the EH periods revealed reddish slips around the rims and lips. Not enough rim fragments were recovered to provide orifice information for the EPH and EH periods. Two urn rims from the LPH period had estimated orifices of 38 cm and 45 cm. Most of the urn sherds were recovered from cemeteries for all three periods.

Lastly, although the Pitrén decorative style and vessel form are formally limited to the EPH period, the mottled semi-resistant surface treatment of this style seems to continue into the LPH and EH periods. It also seems that the red and orange slipped wares of the early El Vergel style, which mainly date to the LPH and EH periods, first appear in the terminal EH period. Unfortuantely, not enough stratigraphic information and radiocarbon dates are available from excavated sites to resolve these chronological issues here. Hopefully, future work at more sites in the Araucania will better define the temporal and spatial parameters of these and other styles.

*Context of Vessel Forms*

Although this topic will be discussed in greater detail in a later publication dealing with artifacts recovered from specific excavation units within sites, a brief comment is warranted here. While little temporal change in the common functional categories occurs, the above discussion of particular forms (e.g., necked and neckless jars, drinking cups, urns, plates, bowls) presented data regarding fluctuations in proportions of different vessel types. Social differences surely existed as well, and will be best revealed when the spatial distributions of forms and functional categories are explored in the later publication. Also, when vessel form and function are compared with paste and surface treatment (including motifs), temporal and intra-site patterns are better revealed.

Vessel form attributes are important in discussions of temporal variation at sites, but another goal of the classification of drinking mugs, necked and neckless jars, urns, and other forms is the identification of the social contexts in which vessels were used at sites. In order to better understand these contexts, three general functional categories were employed in this study: utilitarian (cooking and/or storing), serving (*chicha* and food), and ritual (also *chicha*, food and burial), but considerable overlap may occur or a particular form may sometimes be used for storage and at other times for serving/pouring. Jars (necked and neckless) are the primary forms used in mostly cooking/storing functions. Shallow bowls, because of their open, relatively shallow forms, are well suited for the serving and display of food, but they appear mainly in the terminal LPH and EH periods. (Most plates and bowls were likely made of wood in earlier times.) Ritual ceramics found at *kuel* and *rehuekuel* sites seem to be primarily small neckless jars and drinking mugs (see Appendix III). Although a few sherds indicative of drinking cups were recovered at PU-165, more were excavated at *TrenTrenkuel* (LU-69) and found on the surface of other *kuel* (total=9). A few burial urns were recovered but not often in the context of domestic sites; most were found at cemetery sites. None were associated with the *kuel*.

Within the ceramic vessel assemblage at PU-165, there is considerable continuity in the serving and utilitarian categories represented in LPH through EH contexts. Serving forms (jars) account for ~80 percent of the vessel forms represented for each period. Fluctuations in functional groups are minor between periods, except between the LPH and EH periods. During the EH period, serving and ritual jars account for all of the forms represented, but small sample size could explain their overrepresentation and the lack of utilitarian forms, especially at *kuel* sites. Later, more detailed analyses of these data should confirm or change these initial impressions.

*Temporal Trends in Surface Treatments*

Surface treatments consist of slips, paint, incised decoration and texturing, polishing and burnishing, punctation, negative resist painting, and other plastic modes. Within the PU-165 assemblage of 10,236 sherds, 9.9 percent of the ceramics from excavated contexts have surface treatment. Slipped ceramics total 292 sherds (2.9 percent) and painted ceramics total five sherds. Sherds with incised decoration total 192 (1.9 percent) sherds and those with corrugated texturing total (0.1 percent of assemblage total). Polished or burnished sherds totaled 2,056 (20.1 percent), and the majority (1,277 or 12.4 percent) was polished. Fifty-five (0.4 percent) potsherds had an impressed surface treatment; 1.6 percent had punctation.

Slipped Ceramics: The trend that immediately stands out is the presence of oxidized slips (red and orange) only in the LPH and EH periods and the presence of painted sherds, especially cream and dark red to brown, during the EH period and this pertains to the few Valdivia style sherds excavated at PU-165.

The El Vergel type of the LPH period yielded 191 sherds that had red and orange slips. Slip colors were mainly red and orange; one example of a cream slip was recorded. Five exotic dark maroon slips were also found. Orange slips were on fine to medium tempered pastes, while red slips were primarily on medium to coarse tempered wares. Vessel forms are uncertain because few slips were found on rim sherds. The few recovered ones were primarily associated with short and long necked jars and small to medium neckless jars of the El Vergel style.

The brown and cream reduced slips are present in only the late LPH and EH periods. Oxidized slips, on the other hand, especially dark red and brown, occur in only the EH period. In addition, the percent of slips on untempered ceramics increased to 76.2 percent; most of these pastes were light orange to medium gray. Apart from the slips on untempered pastes, most other slips were on fine and medium tempered ceramics; only five coarse tempered sherds had slips. Several different paste colors were slipped, and while tempered pastes had slips more often, no particular temper appears to have been preferred for slipped ceramics. Only 31 rim sherds had slips during the LPH and EH periods, and these were short to medium everted rim forms.

By the EH period, slip color proportions had changed. The percentage of red slips decreased, while orange in particular increased, accounting for 64 of 101, or 64 percent of the EH slips. Overall, however, slips increased slightly. Slipped ceramics in the assemblage usually did not have other surface treatments, but when others did co-occur, they were usually polishing, or on rare occasion, incised decoration.

Painted Ceramics: Ceramics with paint were rare in the assemblage. During the EH period, monochrome red paint was the principle color used, but bichrome red and white, and brown paint were also recorded. Paint was identified on only five sherds. However, these paints were only found on fine to medium tempered (mostly orange) and medium quartz tempered (gray) pastes. Only two vessel rims with paint (red and dark brown or faded black) were identified, and these were short everted, necked jars.

Incised Ceramics: The incised technique category includes fine line and punctated modes. Incised line techniques account for 1.1 percent of the total ceramic assemblage from excavations; they usually represent decorative treatments, though sometimes lines were incised into the interior bases of vessels. The thinner fine line incision was better suited for the execution of the designs that characterize the LPH and EH motif assemblage. Corrugated texturing techniques, which account for 0.1 percent of the total ceramic assemblage from excavations, are almost exclusively found on utilitarian forms and tempered pastes.

In the LPH, incised fine line decoration was used. Fine line incision characterized the decorated sherd assemblage at excavated sites PU-122, PU-132, and PU-165 during the LPH and EH periods. Incised decoration at these sites was eventually replaced by red-slipped decoration in the EH, though incision continued sparingly.

Fine line incision was found on both tempered and untempered pastes and was less often associated with motifs than fine line incision. Many of the horizontal lines around rims, for example, would have been created using fine line incision, especially when they represented the only decoration on a vessel. As the motifs executed with fine line incision became popular during the terminal LPH and EH periods, fewer, simpler motifs that used fine line incision were created. While during the EH period fine line incision was more often associated with serving jars, it was not associated more strongly with tempered vessels as were other decorative surface treatments were. During the EH period, 4 of 19 (~20 percent) vessel rims with fine line incision were serving vessels. Only two of those vessels had untempered pastes, however, and the remainder had mostly coarse temper (indeterminate vessel forms). Fine line incision was found on a variety of pastes from the LPH period on, but it was more frequently on untempered pastes during the EH period, when it was found on serving vessels.

Polishing and Burnishing. As noted at the beginning of this section on surface treatments, polish was one of the more common ways of finishing vessels. Like other surface treatments, polished, and less so burnished sherds make up moderate proportions of the total ceramic assemblage from excavated strata. While both treatments should result in a high surface luster, burnishing is distinguished by the presence of facets.

Polished and burnished sherds totaled 2,056, and the majority (1,277), were polished. During the LPH, 15.8 percent of sherds were polished and 4 percent were burnished. These were mainly Type 2 and Variety 11B. Proportions of polished sherds increased from the EPH to the LPH periods. The increase in overall proportion of polished sherds in the ceramic assemblage continued into the EH period when polished sherds reached assemblage highs of 21.5 percent. Polished sherds, however, increased by nearly ~30 percent from the EPH to the LPH and EH periods. This can partly be attributed to the LPH and EH use of slips on smoothed to polished surfaces. Smoothed surfaces dominated in all periods, but especially the LPH and EH.

While the relative frequency of burnished sherds steadily increased throughout history, the change in pastes was not nearly as linear or unidirectional as that seen in the polished sherd assemblage. Regardless of the period of occupation, however, polished and burnished surface treatments were almost always found on jar forms.

Punctation: This motif occurs in the form of punched circular holes probably made from a small stick (see Figure 3.1). Some of the holes show drag lines where the tool or stick was pushed into the leather hard clay and then dragged slightly to produce a tear-drop effect. Other punctations are more technically impressions made by pushing the fingernail into the clay.

Other Surface Treatments. Other surface treatments include appliqué, other plastic modes, and differential firing. Most of these treatments are very rare compared to the above categories. Appliqué motifs were usually buttons or lentils. One exception is mold impression which appeared in the EH period at PU-165.

*Covariation of Surface Treatments, Pastes, and Vessel Forms*

The above discussion examined changes within attribute categories: pastes, vessel forms, and surface treatment types. We did not systematically present data regarding the co-occurrence of all traits. Earlier ceramics that stand out as being potentially diagnostic include Pitrén with tempered orange but mainly a gray and brown paste; later diagnostics include red paint accompanied by black, cream or white on Valdivia-type sherds, and orange and red slips on LPH El Vergel and some EH sherds. Ceramic categories confined to the EPH that may be diagnostic of the time period include medium-sized jars with short everted rims and a slight matte to mottled finish, which is similar to but not always a Pitrén style. The frequencies of most other EPH period ceramics are too low, especially when particular motif elements (i.e., burnishing) are considered, to know whether their unique appearance in deposits from this early period is due to their temporal importance or minor variations on vessels.

The majority of the following El Vergel red and orange slipped wares are similar to El Vergel ceramics characteristic of Angol and nearby areas, and other sites whose ceramic assemblages include decorative elements also characteristic of the El Vergel style.

At PU-165 and other sites with LPH fine-line incision, these ceramics are almost exclusively on a very light orange, beige or light gray paste. Similar examples were also recovered from late LPH and EH sites located throughout the Araucania region from the coast to the highlands. Better preserved examples of these ceramics clearly show that this incision is identical to the etching or superficial engraving on vessels that characterize late El Vergel and other late as yet undefined wares (c.f., Mera et al. 2004)

Because slipped, corrugated, punctated, appliqué, incised wares and other varieties throughout the Araucania region are so similar to one another, I believe that all of these likely represent greater contact among the indigenous populations and local expressions of a pan-Araucania decorative design of the late LPH period and later, to a lesser extent, the EH period (~AD 1400-1750). Until the particular attributes of other examples from outside of the Purén and Lumaco Valley can be systematically compared, however, I recommend using different terminology when referring to subregional varieties.

Although painted Valdivia ceramics were recovered only from PU-122 and PU-165, none had motifs that could be subjected to more detailed analysis. Painted motifs, fine line incision, and punctation best characterize the LPH and EH periods. The particular motif elements used in ceramic decoration are presented in figures at the end of Chapter 3. Painted motif elements on the few recovered Valdivia sherds are typical of those found in other areas throughout the Araucania region.

Fine line incised motifs were often horizontal or diagonal lines that were drawn parallel to and below vessel rims usually at the base of the neck or the upper shoulder of the vessel. These probably circled the entire pot. Double and multiple horizontal lines were sometimes evidenced, but variations on parallel line motifs were also used. These linear elements were found in only the LPH and EH periods, with the most robust motif sample at site PU-165. Fine line incisions were mostly on serving jars.

The remaining LPH and EH period decoration was punctated. No particular mode was frequent, but examples are included here nonetheless. Appliqué from the LPH and EH periods was in the form of “buttons” or “lentils.” Fingernail punctation, impressed into a similar paste as the appliqué sherd, is also present Rare preserved painted motifs also occur in EH period strata. One sherd from the Liucura Valley, with black and red painted motifs on both the interior and exterior lip areas on a finely polished graywares, resembles the Aconcagua style of Central Chile. It is on a tempered gray paste. Another sherd has a red painted “comb” motif element that is also similar to Aconcagua ceramics. Despite the similarities with painted motifs on late examples, the ceramics used in the production of these vessels had the same tempered pastes that characterized the remainder of the PU-165 ceramic assemblage.

*Summary of Ceramic Temporal Trends*

Ceramic data from excavated strata were used to assess the changing design of ceramic vessels at excavated sites in the Purén and Lumaco Valley. The LPH and EH occupations at sites was represented only in the upper deposits. EPH period strata were confined to the lower levels. The EPH occupation was much less widely distributed, although represented by more deeply buried strata or levels and thus less archeologically visible. EPH material was recovered from PU-165 and PU-122 excavation units, but also from the surface of a few other sites across the valley. Within all site areas, the occupations with the densest ceramic deposits were the LPH and EH periods, which were well represented in all excavation units but especially at PU-165. In a few site contexts, Spanish roof tiles or *tejas*, in addition to ceramic densities, signaled the temporal/stratigraphic transition between LPH and EH. *Tejas* were found only in level 1 at PU-165 and several tested sites and in levels 1 and 2 at PU-122 and PU-157. While our window into the later period occupation was narrow, no *tejas* were encountered in the earlier deposits, or in any LPH/EH deposits generally deeper than 30 cm below the surface.

The pastes used during the LPH period continued into the EH period. For the most part, changes in the relative frequencies of pastes were minor and gradual. Some of the exceptions include pastes with grog temper in the EH, mainly associated with a few exotic sherds. Orange and gray pastes with medium granite, mica schist, muscovite, syenite, and feldspar increased steadily over time. Temporal patterning in the ceramics stands out better when attributes besides pastes are examined.

The proportions of the vessel function categories remain similar over time, with the exception of small to medium everted rim jars, which account for higher relative frequencies in the LPH and EH periods. Serving vessels in the form of jars and drinking vessels vary temporally between 76 and 86 percent, but changes in particular forms occurred. Drinking vessels and shallow bowls increased in relative frequency from the terminal LPH to the EH periods; as noted earlier, most serving bowls (and plates?) were probably made of wood and reeds as evidenced in the historic period and documented by chroniclers. Other vessel categories (e.g., bottles) were very rarely used and account for less than 0.01 percent of the EH period assemblage.

Vessel wall and lip attributes experienced some changes over time as well. On necked jars, while general wall orientation remained similar over time, rounded lips, tapered, and abrupt angle/flat lips increased in occurrence. With jars, the prominent wall forms became more varied over time. For example, during the LPH period, most jar walls had forms outsloping straight or outsloping concave necks, but beginning in the EH period, most wall shapes were outsloping concave. Lips on jars also underwent changes. While rounded lips were common in all periods, the relative frequency of flat lips increased while tapered, albeit still dominant, decreased slightly. Necked jars went from having mainly vertical and slightly excurved necks with flat and rounded lips in the LPH period to having mainly more everted curved necks and tapered lips in the EH.

Rim orifice diameter trends are compared here by period and vessel form in figures at the end of Chapter 3. Even among some common jar vessel categories the number of rims was very low for all three periods. The results of rim orifice measurements should be viewed as tentative because diameters could not be consistently assessed, partly contributing to the low batches of measurements for some vessel assemblages.

Just as the pastes used in certain vessel forms may clue us in to their use contexts (e.g., more tempered serving vessels used on special occasions or in elite contexts than tempered serving vessels?), size categories within functional categories may represent varying uses. The smallest jars, for example, could have served as serving or utilitarian uses. Vessels of different sizes, whether they were utilitarian or serving, could reflect the amount of food that they were meant to hold. Finally, some size classes within vessel form categories could have been food-specific, storage-specific, and, in the case of large urns, burial specific.

Within the surface treatment assemblage, several trends were observed. Ceramics with polished texturing on medium to coarse tempered pastes slightly decreased over time, polishing on mostly fine tempered pastes, on the other hand, increased. Within the decorated sherd assemblage, there is a marked increase in the relative frequency of fine line incision on serving vessels. Painted decorations, while present in the terminal LPH and EH periods (e.g., Valdivia style), make up very minor proportions of decorative treatments. Considerable change in the colors used in slips also took place. During the LPH and EH periods, orange and red slips and red and white paints were most common.

Because the motifs on Valdivia wares (Type 13) are not described in great detail or well illustrated in published documents, rather than assuming that the detailed motif, paint, slip and paste combinations are the same, similarities have been noted with published descriptions of these types. Depending on the wall orientations (outsloping, vertical), the motif panels on Valdivia ceramics are usually on vessel exteriors with the exception of shallow bowls.

The presence of a few Valdivia sherds during the terminal LPH to EH period probably reflects the introduction of these ceramics from areas farther south. Also, like their incised counterparts, Valdivia period painted decoration may have employed simpler motifs than those used during the later periods farther south. The few painted ceramics at PU-165, however, appear not to have the triangle-filled back panels that characterize most Valdivia pottery. While similar motifs occur at LPH and EH sites in other areas, the less complex configuration of the Valdivia ceramics may mean that they initially date to the terminal LPH (AD 1450-1550?).

During the EH, particular ceramic attributes reflect a considerable amount of continuity with the LPH past, while others suggest a few different innovations or influences which possibly derived from other indigenous groups (emigrants from areas of conflict to the north or south?) or from contact with the Spanish. New, regularly occurring ceramic attributes include decorative modes, especially fine line incision, motifs (e.g., fine incised parallel lines), glazes, and exotic slips (e.g., dark maroon). Ceramic pastes appear similar to earlier ones, with varying degrees of fluctuation reflected in their relative frequencies.

## Chapter 6: Ceramic Spatial Patterns at Surface and Excavated Sites

Tom D. Dillehay, Paige Silcox, and Jeff Young

*Introduction*

Inter-site patterns were assessed using data collected from excavated block units, test trenches, and shovel tests. Because LPH and EH materials were confined to the uppermost strata in excavated areas, and because shovel tests probed only the uppermost 40 to 50 cm of soil, there is a likelihood that the majority of surface collected materials date to the LPH and EH period occupation at sites. This should hold true especially for sites located near the *kuel* and *rehuekuel* complexes, where deposits that predated the LPH period yielded comparatively few materials. Therefore, we continue with the discussion of inter-site trends under the assumption that most materials recovered from the uppermost 40 cm of soil represent the LPH and EH period occupation and not others. This working assumption is supported by the test and block excavations in 17 excavated sites.

Appendix III displays the frequencies of the ceramic type groups represented in the surface assemblage from all sites. Surface collections yielded 2,672 sherds at PU-165. What appears to be more important is the kind of vessel form, in particular the primary inferred function (e.g., serving, utilitarian, ritual), and the presence or absence of *kuel* architecture at many sites. The shovel test and block excavation distributions of vessel function categories indicate that while all contexts had both serving (small jars, cups, and shallow bowls) and utilitarian forms (jars and bowls of all sizes), the current evidence suggests that the latter were not found on *kuel* structures (nor were they immediately adjacent); they are found in domestic and old *nguillatun* fields, the latter also associated with food preparation and consumption during ceremonies. The mot frequent vessel types at kuel were shallow jars and small drinking mugs (the latter distinguished by straight rims and handles placed directly on the lip and rim).

While there is variability by excavation location, small serving to medium-sized jars account for larger proportions of the respective assemblages than utilitarian vessels. Although excavated *kuel* contexts had more possible ritual serving jars and other vessels, surface distributions did not mirror this pattern, and the largest collection (n=7) came from LU-69, the large *TrenTrenkuel* site located at the conjunction of the Lumaco and Purén rivers.

While small drinking vessels and serving jars appear strongly associated with *kuel* architecture, which dates only to the LPH and EH periods, it is important to remember that they also were recovered from domestic contexts, though the latter also had all other vessel forms. This simply indicates that in all excavated and shovel-tested site areas, food (including *chicha*) was being served and consumed out of small to medium jars, sall cups, and shallow bowls, and liquid (i.e., *chicha*) was prepared and stored using small to large jars and pitchers (necked and neckless). The higher proportion of drinking vessels at *kuel* (11 percent versus 3 percent at domestic sites) probably relates to the consumption of *chicha* at these sites, a supposition supported by the presence of corn phytoliths in all levels of *TrenTrenkuel* or site PU-69 (Iriarte n.d.; Dillehay 2007).

Orifice diameters of serving vessels were compared by site context. If ritual leaders were drinking *chicha* and consuming food on top of *kuel*, then we should expect that serving vessels found in *kuel* would be smaller, on average, than those recovered from domestic contexts or off-mound contexts. While a range of vessel sizes, inferred from orifice diameter, exists within each vessel category, and within some categories (bowls, jars), some of the largest outlier diameters were from off-mound domestic contexts. On average, *kuel* contexts have fewer sherds with smaller orifices (~5-9 cm) than off-mound contexts (~7-30 cm), keeping in mind that few sherds were recovered from excavations in *kuel,* thus presenting a sampling bias.

The orifice diameters for the most frequent cooking and storage vessels are also briefly compared. If food and drink for sponsored ritual feasts were prepared in the same contexts where they were served on or near the *kuel* (and the old *nguillatun* ceremonial fields), then we might also expect there to be a direct relationship between *kuel* and vessel orifice diameter. Due to the small sample size of orifice diameters of serving vessels from domestic and *kuel* contexts, we cannot determine any associations in a statistically meaningful way, although the present data base suggests there is meaning in the numbers and contexts.

The above comparisons of vessel rim orifice diameters in different contexts used the entire assemblage for particular forms—whether a sherd was decorated or not, for example, was not considered. Decoration is another dimension of serving vessels that can inform ritual or elite practices because decorated variants were likely to bear social or political messages when situated within the context of lineage expansion, alliance building, and the manipulation of relationships between frontier groups during the terminal LPH and EH periods. Because the PU-165 period motif assemblage is characterized by incision on serving vessels, fine line incised motifs were separately compared for their surface distributions, then by excavated architectural and "other" contexts. Because the sample of incised serving vessels is so small, all sherds with incision were plotted, but as the motif sample discussed above showed, the majority of incised sherds were from serving vessels.

*Inter-Site Functional Comparisons*

The table below presents the total number of ceramic types (n=17, with the two varieties for types 1 and 11 included thus making it a total of 17) appearing at different site types (n=7).

Total site types: 7 Total ceramic types and varieties: 17

| Site Type | Ratio total ceramic types | Percentage of types |
|---|---|---|
| 1) Domestic | 17/17 | 100% |
| 2) Cemetery | 13/17 | 76.5% |

| | | |
|---|---|---|
| 3) *Kuel* | 13/17 | 76.5% |
| 4) Agricultural Terrace | 2/17 | 11.8% |
| 5) *Cerro Sagrado* | 3/17 | 17.7% |
| 6) Channelized Field | 2/17 | 11.8% |
| 7) Fortress | 4/17 | 23.5% |

<u>Cemetery (C) and Domestic/Cemetery (DC)</u>

The ceramic types that were found in both site categories are types 1, 2, 3, 5, 6, 7 and 10 and Variety 11B. The types recovered demonstrate EPH to EH occupations based on the presence of types 5 and 7, both described as among the earliest ceramics found in the valley. Type 2 was the most common sherd found at domestic sites but was only the third most common type found at cemeteries, pointing to a more domestic use. Types 3 and 10 were found at domestic, *kuel*, and cemetery sites. This could be interpreted as a possible link to a ceremonial context as both cemetery and *kuel* sites are sacred. Variety 11B ceramics were collected from nearly every site type except for channelized fields and the *Cerro Sagrado*, so it is not surprising to find it at cemeteries as well. Missing at cemetery and domestic/cemetery sites are types 4 and 13 and varieties 1B and 11A, and exotics.

Exotic ceramics were absent from the surface collections at all cemetery sites. This is not surprising since exotics were found at only domestic sites, but this also may be a sampling problem. Type 13 was also absent and found in only excavations at two domestic sites. Variety 11A was recovered most commonly at domestic sites but was also found at *kuel* and the *Cerro Sagrado*. Since *kuel* and *Cerro Sagrado* sites both serve ritual functions, it seems logical that they would also be found at cemeteries. One possible explanation is only the lesser ranked social populace was placed in formal cemeteries, but there is no current burial evidence for this, or Variety 11A may have been reserved for a particular purpose or social status. Type 4 and Variety 1B were found at domestic and *kuel* sites but not cemetery sites. These are late sherds and the majority of cemeteries predated the appearance of Type 4 and Variety 1B ceramics

Baed on the available data, there seems to be a link in the LPH period between the domestic and sacred sites. Two types of pottery were found exclusively at domestic sites, cemeteries, and *kuel:* types 3 and 10. These sites were relatively small, less than 5.5 ha in size, and located along the main river channel. This trend may not have continued into the later EH period, as only one cemetery was occupied in the late period, which again presents a sampling bias in the data.

<u>*Kuel*</u>

The ceramic assemblage of the *kuel* was in general diverse, yielding 13 of the recognized 17 ceramic types. Type 2 and Variety 11B were the most common ceramics found. Type 2 ceramics, as has been noted previously, were found at every type of site in the study area. The second most common ceramic at a *kuel* is Variety 11B, which was found at every site type except the *Cerro Sagrado* and channelized fields. The finding of these two types in quantity demonstrates the importance of *kuel* by showing the ubiquitous use and possible leaving of offerings (or consumption of *chicha*) through all time periods. Most sherds of drinking cups were of Variety 11B and found in *kuel*. The *kuel* often overlapped various time periods with two *kuel* (*Maicoyakuel* and *TrenTrenkuel*) being continuously in use through all ceramic time periods. This lends weight to the idea of the *kuel* perhaps being a binding aspect in the valley across the LPH and EH periods (Dillehay 2007).

The higher proportions of serving vessels (e.g., small jars) in contexts with *kuel* suggest sponsored feasts in this context. The distribution of slipped and incised pottery indicates that sherds with the more complicated, central components of these attribute types were only moderately associated with larger scale *kuel* architecture.

Spanish and Chilean Fortresses

There were three fortresses that contained ceramics. The most common ceramic types are Type 2 and Variety 11B followed by types 8 and 7. This is a fairly low diversity of types with only 4 of 17 present. The lack of ceramic diversity possibly suggests the fortresses were used for shorter periods of time and the presence of fewer and less diverse indigenous people living at and around them as well.

Channelized Fields

Channelized fields containing ceramics are rare with only two types present. Fields are similar to agricultural terraces for the least diverse assemblages, having only 2 of 17 types. The majority of ceramics recovered were types 2 and 8.

Agricultural Terraces

Terraces contained eight Type 2 sherds and one Variety 11B sherd. This low density of sherds is most likely related to the agricultural function of the terraces. There was probably little need to have ceramics present at this stage of food production.

*Cerro Sagrado* (Sacred Hill)

Only 1 *Cerro Sagrado* was identified as having surface ceramics. This site had a low ceramic diversity with 3 out of 17 types. Most common were Type 2 ceramics followed by Type 8.

Domestic Sites

Domestic sites contained 17 of 17 ceramic types found on the surface and in excavations. Two types are found only in a domestic context (Variety 1B and the exotics). The most common ceramic is Type 2 with nearly 50 percent of the total ceramic count. Variety 11A, which overlaps in placement with *kuel* and the *Cerro Sagrado*, is the second most common. The remaining types were all found but in smaller amounts. Nine domestic sites were continually occupied from the early through to the late period.

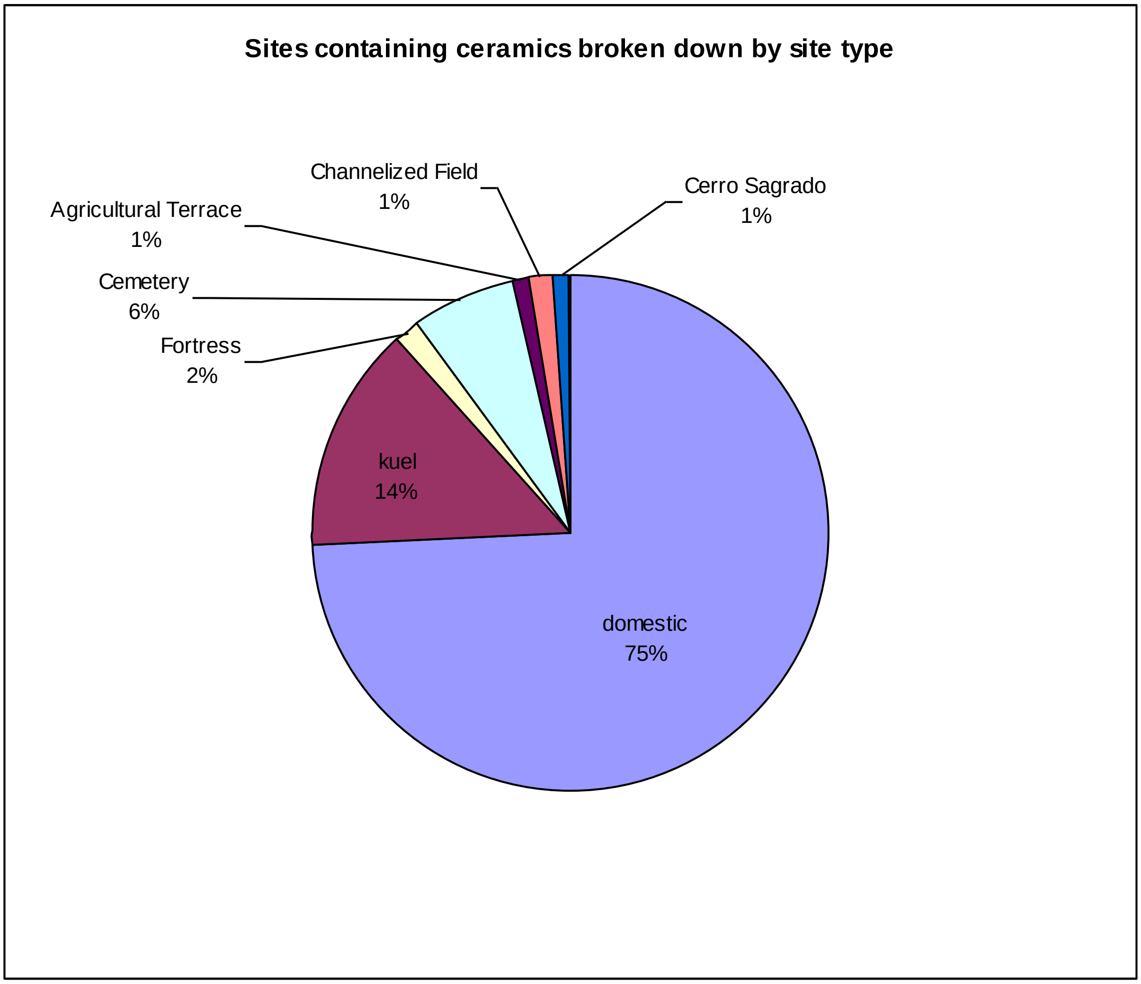
The medium to larger sizes of jars from domestic sites suggest that responses to the demand to serve larger portions of food to larger groups of people are reflected in the serving vessel assemblage. Additional support comes from the increased assemblage of later EH bowls and plates with incised decoration; these serving forms were found more often in domestic contexts. The widest variety of size categories were expectedly found in domestic sites.

*Spatial Distribution and Intersite Comparison*

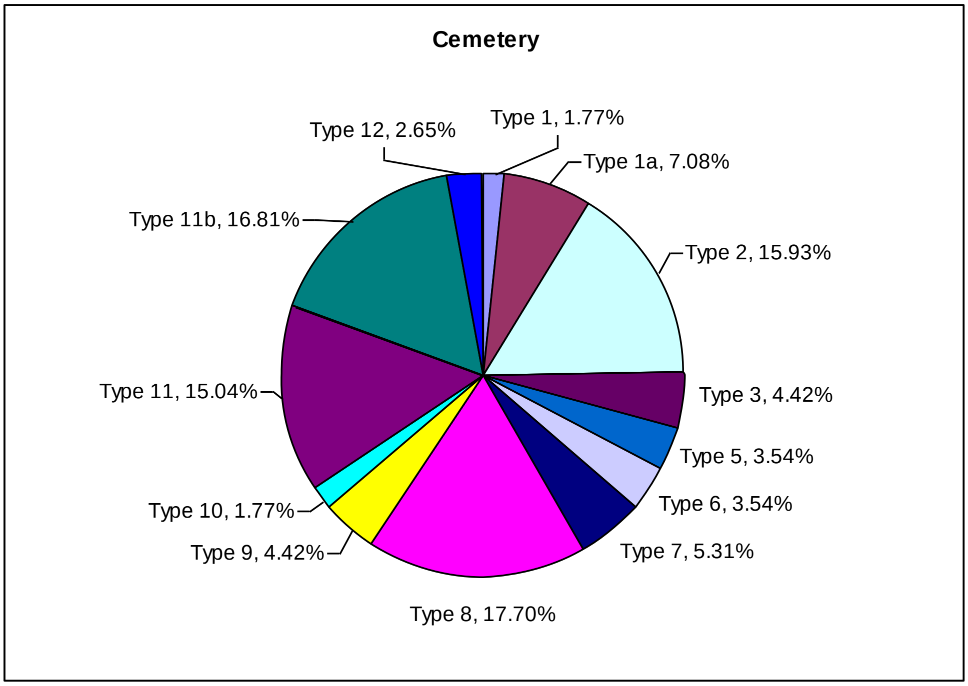
The following ceramic distribution patterns are based on only surface collected ceramic types, because the addition of the excavated types, especially PU-165, would skew the sampling pattern. However, preliminary results of ceramic analysis from excavated sites indicate similar patterns to those described for surface collections from both unexcavated and excavated sites. In general there are a few apparent patterns when all ceramic types are taken into consideration. There is a noticeable reduction of sites containing ceramics in the southern Purén Valley. Whether this scarcity is due to site conditions, sampling bias, social and political factors, and/or cultural reasons is unclear. There are many sites located on this side of the valley, at no greater or lesser concentration than in other areas of the valley, though site type may be one factor as there is a high frequency of *nguillatun* sites on this side of the river. No old *nguillatun* sites contained visible surface ceramics. In addition, there is a lower frequency of domestic sites in this area, the most frequent site type to contain ceramics. Even given these factors, however, there are some domestic sites that have few surface ceramics which suggests that if site type is a factor, it is likely not the only one. The only exception to this is PU-177, a small domestic site in the southern Purén Valley, just above the valley floor, with six different types of sherds.

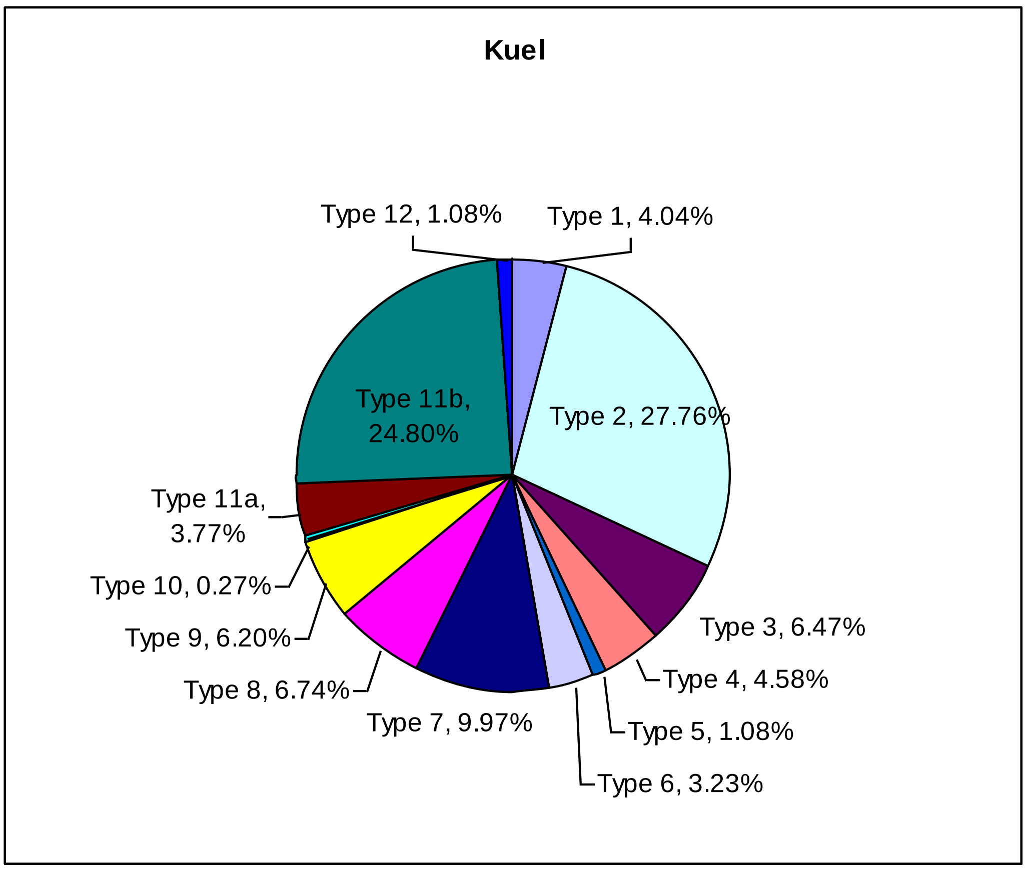
Another noticeable pattern is that there are certain sites that tend to contain ceramics of numerous types. These sites include PU-165, containing 14 ceramic types, many in high frequencies; PU-10, a small domestic site containing 11 different types; PU-122, a domestic site containing 10 types as well as two *kuel;* PU-38, a *kuel* containing eight ceramic types though in rather low frequencies; and LU-69, a *kuel* containing eight ceramic types, some in high frequencies for a *kuel* site. One final site of note is PU-260, which while it contained only six types of ceramics, two in relatively high frequencies, stands out as a cemetery site and is located in an isolated area to the north in the hills above the Purén Valley.

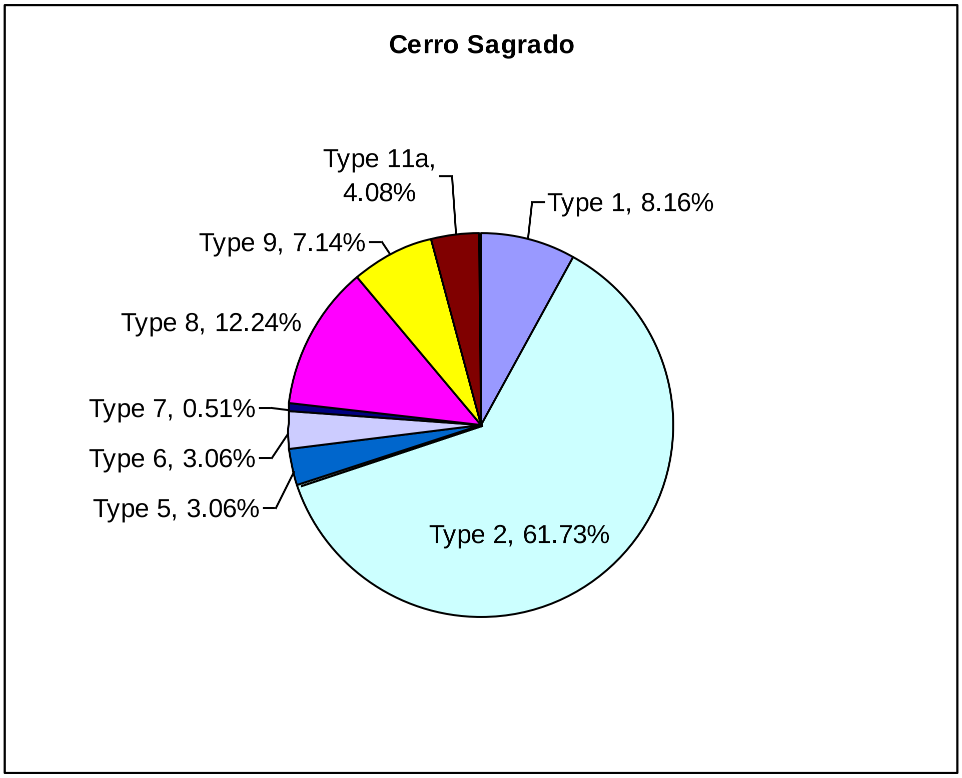
It is clear that the most frequent type of site where ceramics are found is domestic sites. Seventy-five percent of all sites containing ceramics are domestic locations. This makes sense, given that domestic sites would naturally be where ceramics were most frequently produced and used in a functional way most frequently. The next most frequent site type is the *kuel*, with 14 percent, cemeteries with 6 percent, fortresses with 2 percent, and *Cerro Sagrado*, agricultural terraces, and channelized fields with 1 percent each. The frequency of ceramics found at *kuel* is interesting and indicates a likely ritual use as does the frequency of ceramics found at cemeteries—the latter as grave goods. The low frequency of ceramics among the agricultural sites is not surprising; however, it is interesting that the low frequency of ceramics found at the *Cerro Sagrado* and the absence of ceramics at old *nguillatun* sites may indicate less use of ceramics in rituals at these kinds of ceremonial sites or, more likely, the cleaning of these places before and after ceremony to prevent sorcery (see Dillehay 2007). Below are charts showing the percentage distribution of ceramic types at all site types.



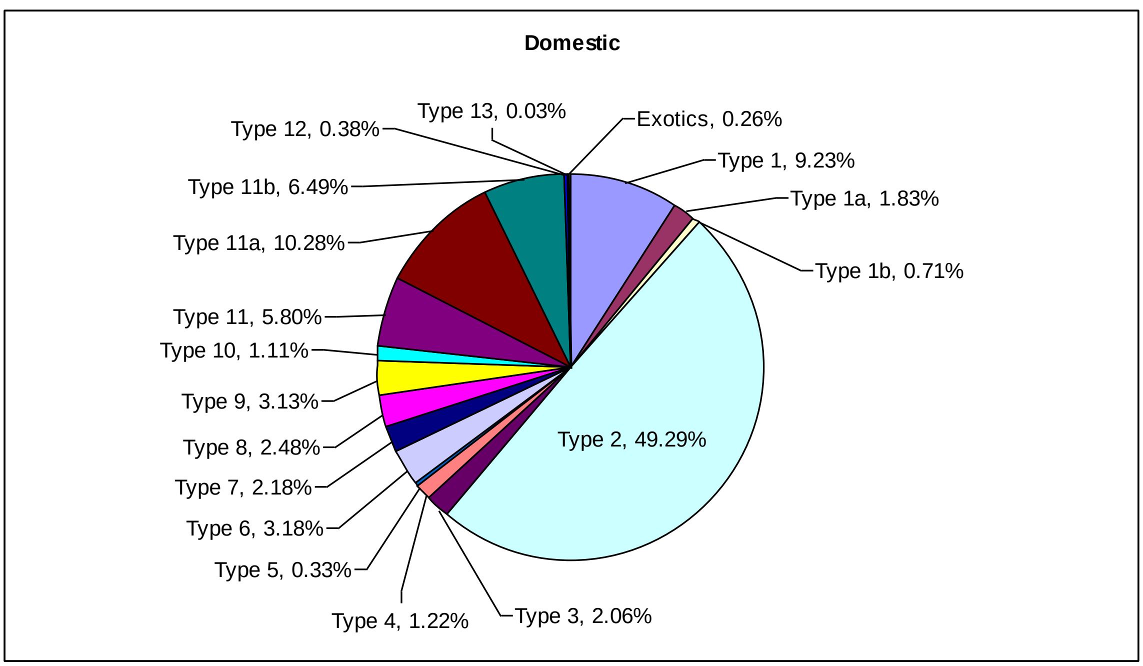

Type 2 ceramics are the most frequent type of ceramics found at all site types, except at cemeteries. In fact, Type 2 ceramics account for nearly half of all ceramics. For example, 89 percent of the ceramics found at agricultural terrace sites are Type 2, 85 percent at channelized fields, 62 percent at the *Cerro Sagrado*, 49 percent at domestic sites, and 44 percent at fortress sites. The frequency of Type 2 ceramics at cemeteries (16 percent) and *kuel* (28 percent) stands out for this reason. While at *kuel*, Type 2 is still most frequent, it is closely matched by Variety 11B at 25 percent. And at cemetery sites (6 percent), Type 2 (16 percent) ceramics are second to Type 8 (18 percent), Variety 11B (17 percent) and closely followed by unspecified Type 11 (15 percent). This may indicate some ceremonial significance to Variety 11B ceramics, since they appear in higher frequencies than Type 2 ceramics at cemeteries and *kuel*, both sites where rituals occurred. Possibly Type 8 ceramics have a similar significance, given their high frequency at cemeteries as well as at the *Cerro Sagrado*, where they are the second most frequent type at 12 percent. Another reason for the high frequency of Type 2 may be vessel size. These are the largest vessels in the assemblage and were probably used for storing liquids, including *chicha*, which would have been consumed during ritual ceremonies at cemeteries and *kuel*.


Cemetery
Type 12, 2.65%
Type 1, 1.77%
Type 1a, 7.08%
Type 11b, 16.81%
Type 2, 15.93%
Type 11, 15.04%
Type 3, 4.42%
Type 5, 3.54%
Type 6, 3.54%
Type 10, 1.77%
Type 9, 4.42%
Type 7, 5.31%
Type 8, 17.70%


Kuel
Type 12, 1.08%
Type 1, 4.04%
Type 11b, 24.80%
Type 2, 27.76%
Type 11a, 3.77%
Type 10, 0.27%
Type 9, 6.20%
Type 3, 6.47%
Type 8, 6.74%
Type 4, 4.58%
Type 7, 9.97%
Type 5, 1.08%
Type 6, 3.23%




Other ceramic types that appear in high frequencies among all site types are Variety 11B and Type 8. At most sites these two types are the second most frequent after Type 2. One interesting exception to this is domestic sites, where the second most frequent Variety is 11A. This is not a frequent type at other site types, however, possibly indicating its sole functional use for domestic purposes, such as food preparation or storage.



Lastly, the EPH is best represented by types 5 and 10 and Variety 11B. These are located primarily at domestic sites in the Purén, Lolonko, Quitrahue and Rapahue and Ipinco areas of the central valley, with a few placed in Lumaco. For the LPH (types 1, 2 and 6), this trend continues but with a higher density in Purén, Rapahue, and Maicoya in the central valley. Exotics 12 and 13 are only near Purén and Maicoya in the western and central part of the valley. The EH pattern closely follows that of the LPH period.

*Discussion*

As described above, there are some clear spatial distributions among the ceramic types and vessel forms, specifically with regard to *kuel* and cemetery sites. Fortresses were particularly problematic because the ground visibility was very limited, though we could observe in shovel test and canal drainages that generally thin cultural deposits are associated with thiese sites, suggesting a low density of artifactual material in them. We should caution, however, that due to low archeological visibility in many areas, especially in the floodplain where vegetation was dense, the surface ceramics receovered from sites was minimal, thus skewing the sample size and variability. Nonetheless, the consistency of patterns across the entire study area tends to reflect similar type/variety trends despite any sampling biases.

Intra-site and inter-site variation in the distribution of ceramic types may reflect the types of activities that required the use of the ceramic vessels. For instance, the most prevalent types, types 2 and 11, occur primarily as jars, suggesting that they were probably used for similar types of activities. Small to medium sized jars were probably used for preparing, cooking, and serving food. Larger and taller jars were probably used for storage and the largest served as burial urns, although very little evidence of the latter was found. Although some jars were used for storage and others used to serve food, most were probably used for cooking. Limited evidence for a few drinking cups and food bowls and plates was also found, and these were found primarily in domestic sites, although small jars and drinking mugs were the dominant forms at *kuel*.

Future publications will present excavation data from specific activity and domestic areas with various sites. This information should add to and clarify some of the temporal and spatial patterns discussed here.

## Chapter 7: Intepretative Discussion

Tom D. Dillehay

*Introduction*

Although stylistic analysis provided insight into the provenience of ceramics, compositional analysis of the paste aided in differentiating local products from imports and thus provided a means to investigate intra-valley and inter-regional interactions. Both the INAA and petrographic studies showed that ceramics in the study area had varied compositions and some were of non-local origin. Stylistic analysis produced a similar conclusion. Based on style, distant southern (e.g., Valdivia), northern (i.e., Aconcagua?), and eastern (Andean mountains) origins were proposed for several non-local wares. Surprisingly few Valdivia painted wares were found in the study area, which may partly be attributed to a sampling bias, but this is doubtful, given the extensive excavations carried out at a few sites. It is likely that this type is most prevalent farther south in the Cautín, Tolten, and Valdivia river basins. As for its chronological placement, I suspect that the Valdivia style dates slightly before the Spanish contact period and increased in popularity during the EH period. The major stylistic affinities of the Purén and Lumaco ceramics, however, point to the coastal plains to the west (e.g., Tirua, Ca**ñ**ete, Lebu) and to the south-central Araucania valley (e.g., Angol, Chol Chol, Los Angeles, Traiguen).

Although few ceramics were recovered from contexts at PU-165 and other sites that predated the LPH, the EPH sample (mainly Pitrén) is too small to confidently comment on early ceramic patterns in the valley. Based on the INAA and petrographoic studies, we can suggest that most EPH to EH ceramic production occurred at domestic settlements in the valley, perhaps in closer proximity to sites located along the river where the major clay sources are situated.

Three different compositional groups were petrographically identified by our analyses, along with unattributed specimens of atypical composition. Two main groups are identified as local. One is characterized by a metamorphic granite-derived paste composed of various minerals (e.g., quartz, plagioclase, biotite, hornblende, mica, syenite, and other fragments) and chemicals (see Chapter 4). A second group also of mixed metamorphic composition was local, on the basis of geological, chemical, and mineral abundance criteria (e.g., schist, muscovite, schist, various chemicals). Ceramics with exotic pastes displayed volcanic origin to the east in the Andes or a rare composition (e.g., hematite) not corresponding to the local geology. The petrographic analysis of 39 specimens suggests that at least 10 percent of the ceramics found in the collection were of non-local production. This figure roughly conforms to the finding of the INAA and stylistic studies. The INAA study yielded an additional picture of ceramic production and interaction in the valley. Three paste groups were identified, along with several exotics. Although the INAA study revealed fewer exotics than the petrographic study, we should caution that the former has more technical restrictions in the identification of non-local paste and sherds (e.g., Stoltman and Mainfort (2002). It should also be noted that there is more internal variation in the 17 ceramic types and varieties than expressed in these analyses, which should be studied in greater detail in future investigations.

In general, the ceramic assemblage showed considerable continuity existing alongside limited innovation and change in certain attributes. This suggests that the majority of the assemblage during the LPH and EH was largely indigenous to the region; however, other new influences or innovations for change also occurred during both periods. Influence was probably partly related to an increasingly cohesive valley population that was associated with the slipped, painted, and incised ceramic styles that became widespread during the late LPH and early EH periods (~AD 1500-1650), and that had co-opted indigenous elements of Purén, Lumaco, and neighboring areas. Changes in styles were contemporaneous with probable emigration, recruitment and/or annexation of outsiders. The appearance of intrusive exotics in the terminal LPH and EH periods at several sites reflects the presence of non-local groups (or in-married women?) from outside areas. This appearance occurred around the time that demographic and settlement shifts were observed for the valley as well as areas farther south (see Dillehay 2007). The presence of Spanish influence in the indigenous ceramics was rare, though a few pure Spanish objects were recovered (e.g., roof tiles or *tejas*, glazed wares). The absence of European crops (e.g., barley, wheat) and animals (cows, pigs, though horse bones are found in EH levels) confirms this rarity (Silva n.d.). It is likely that more Spanish and European artifacts would be found at ecevations in the early Spanish fortresses near Purén (see Dillehay and Saávedra 2010).

The settlement evidence at the type site of PU-165, combined with the emerging picture of settlement and community patterns, suggest that at the same time that the valley population was in a stage of flux, it experienced a surge in population from the outside during the EH period. During the terminal LPH to EH transition, the period saw significant increases in the number and size of settlements (Dillehay 2007; Dillehay and Sáavedra 2010). This is probably the result of demographic changes resulting first from the Inca defeat of the Araucanians or Mapuche in Central Chile and the later defeat of the Inca by the Spanish, which surely had demographic repercussions as far as the Araucanians living south of the Rio Bío Bío, and second from population displacement of Araucanians in conflict with the Spanish and moving to more securely defended areas such as Purén and Lumaco. These larger scale patterns seem to be reflected within the Purén and Lumaco Valley, not only by the changes in the ceramics assemblage, but in the expansion of settlements at key locations such as Purén and Lumaco, which are the western and eastern entryways into the valley, respectively (Dillehay 2007).

At the outset of this study, we hypothesized that the Araucanians, because of their frontier location south of the Bío Bío River and the dynamic quality of the frontier as a major zone of contact and military interaction with the Spanish, would have annexed and recruited other people to sustain or increase their populations to defend their territories and the so-called *Estado*. The most prudent of the strategies that indigenous people in the Purén and Lumaco Valley could have pursued would have placed them in the position of brokering, or mediating, the diverse interests that would have intersected during Spanish threats to and sporadic expansion into the region. The extent to which these hypotheses can be tested archeologically, however, is limited to statements about the presence or absence of ceramic types, other artifacts, including European crops and domesticated animals, and the degree of cultural variability at valley sites. Further, the assessment of the above model, especially the extent to which non-local Araucanians beyond the study area were invited to ceremonies and feasts, annexed, or recruited, cannot be fully examined without more excavated data from more sites and more study of the written documents. Nonetheless, as suggested in the documents and the archeology, there are storng hints that this model was operating at certain times at certain locales in the Purén and Lumaco Valley during the late 16th to middle 17th centuries (Dillehay 2007).

Based on ethnohistoric accounts of Purén and Lumaco's position within the resistance campaign, the principle Spanish goal that drove their sporadic interactions with the valley populace was to achieve a stable and defensive regional political climate. Acting as mediators between the goals of the Spanish and enemy Araucanians, some local friendly indigenous groups needed to negotiate agreements with the principle producers of the *Estado* and the region as a whole. The sharing of Spanish symbols would have been one way to confer benefits to those who accepted the prospect of Spanish influence, but this is possibly seen in only one sherd in the entire valley collection. The components of the ceramic assemblage that might have conveyed agreements among local indigenous leaders resisting the Spanish included El Vergel red and orange slipped wares, Valdivia painted wares, and possibly incised serving vessels that were continuously produced during the Early Hispanic period, as evidenced by their presence in radiocarbon dated levels 1 and 2 at various sites, but especially PU-165. If this suggestion accurately reflected local Araucanian strategies, then we should expect to find these ceramics occurring widely throughout the valley, but to be somewhat concentrated in ceremonial and/or *kuel* contexts. The former case is true, not the latter. This implies not only minimal to no Spanish influence within the local indigenous population, but none evident in ceramics associated with activities at *kuel* and other special sites.

In summary, several different aspects of the ceramic vessel assemblage lend general support for the hypothesis that Purén and Lumaco lineages were engaged in strategies of resistance, recruitment and annexation. The presence of several exotic types, as evidenced by stylistic, petrographic, and INAA studies, suggest some co-residency between Purén and Lumaco groups and non-local Araucanians. Exotics also could imply the presence of in-married women or trade items, however, we favor the former hypothesis given the historical circumstances of the period under study. The rarity of Spanish artifacts suggests that they were not employed in local domestic sites and in sponsored public activities at *kuel*. The widespread absence of Spanish attributes on local ceramics also argues against any prolonged and effected Spanish presence in the valley at the outset and during the EH period. The scarcity of Spanish materials recovered from the surface of early fortresses, where we would expect a greater number of intrusive artifacts, also indicates short periods of occupation. At these and a few other sites, ceramic roof tiles or *tejas* are present as well as a few porcelain and glass fragments, but not in the portions we have observed at other localities (i.e., Villarrica, Valdivia) where the Spanish were present for lengthier periods of time.

One possibility that could change, probably enhancing, the interpretations of the data and model presented here is that the entire *Estado* was engaged in an exchange system of people, which is likely to have occurred and also would account for part of the ceramic variability in the study area. This would require a different research perspective, in which a wider interregional study directed toward understanding inter-community relationships would be necessary. In this case, the hypotheses tested here would still apply, but at a different and larger scale of analysis. More in-depth analysis of survey and excavated sites throughout the *Estado* area also would be an important test of the larger role that Purén and Lumaco served more generally in the defense of the Araucania.

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# Appendix I: Radiocarbon Dates* #

| Site No. / Lab No. | Provenience | Conventional 14C-Age +/- STD [BP] | CalAge p(95percent) [calBC/AD] | CalAge p(95percent) [calBP(0=AD1950] | $\delta^{13}C^{0}/_{00}$ |
|---|---|---|---|---|---|
| Domestic PU-165<br><br>A203868 | Burned corn in house floor.<br><br>Associated with El Vergel, incised, and Valdivia sherds.<br><br>Levels 1-2. | 430 +/- 40 | 1380 – 1540 calAD | 570 - 410 calBP | -11.0 |
| Domestic PU-165<br><br>AA64654 | Charcoal in upper use surface.<br><br>Associated with El Vergel and incised sherds. Levels 2-3. | 660 +/- 40 | 1220 – 1420 calAD | 730 – 0530 calBP | -25.7 |
| Domestic PU-165<br><br>A-13772 | Hearth in middle use surface.<br><br>Associated with Pitrén and few El Vergel sherds. Level 4. | 1315 +/- 50 | 600 – 800 calAD | 1350 -1150 calBP | -25.0 |
| Domestic PU-165<br><br>AA64657 | Charcoal in middle use surface.<br><br>Associated with Pitrén and other sherds. Level 5. | 1615 +/- 40 | 330 – 570 calAD | 1620 – 1380 calBP | -26.2 |
| Domestic PU-165<br><br>AA64651 | Charcoal from hearth in middle use surface.<br><br>Associated with Pitrén and other sherds. Level 5. | 1680 +/- 40 | 210 – 450 calAD | 1740 – 1500 calBP | -25.3 |
| Domestic PU-165<br><br>AA64980 | Charcoal from hearth in middle use surface.<br><br>Associated with Pitrén and other sherds. Levels 5-6. | 1715 +/- 60 | 170 – 450 calAD | 1780 – 1500 calBP | -25.9 |
| Domestic PU-165<br><br>AA64645 | Charcoal in middle use surface.<br><br>Associated with Pitrén and other sherds. Levels 5-6. | 1735 +/- 40 | 190 – 390 calAD | 1760 – 1560 calBP | -26.1 |

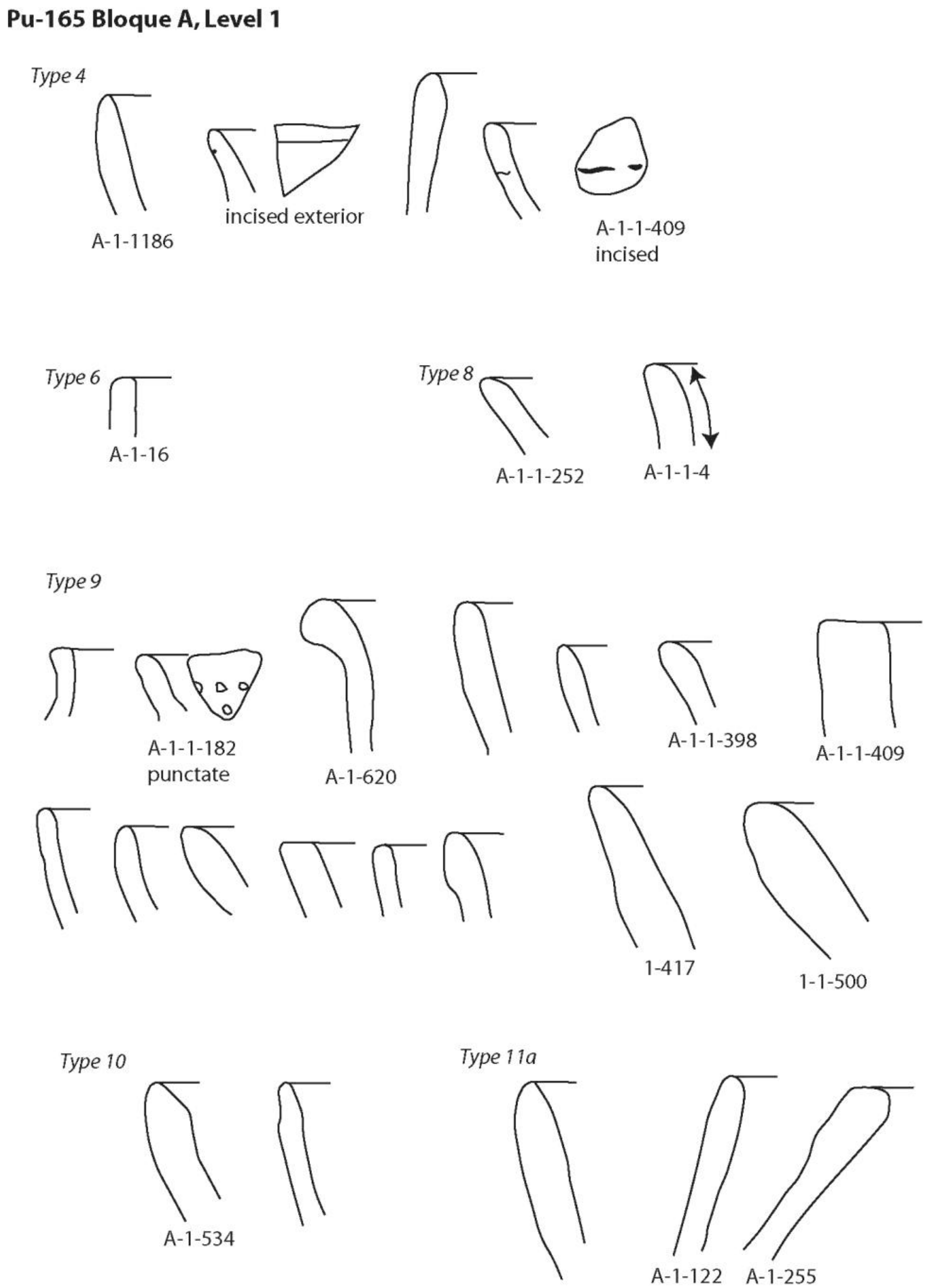
| | | | | | |
|---|---|---|---|---|---|
| Domestic PU-165<br><br>AA64655 | Charcoal from hearth in middle use surface.<br><br>Associated with Pitrén and other sherds. Levels 5-6. | 1740 +/- 35 | 190 – 390 calAD | 1760 -1560 calBP | -25.0 |
| Domestic PU-165<br><br>AA64979 | Burned area in middle use surface.<br><br>Associated with Pitrén and other sherds. Levels 6-7. | 1780 +/- 40 | 90 – 370 calAD | 1860 – 1580 calBP | -26.4 |
| Domestic PU-165<br><br>AA64647 | Charcoal from hearth in middle use surface.<br><br>Associated with Pitrén and other sherds. Levels 6-7. | 1800 +/- 40 | 70- 350 calAD | 1880 – 1600 calBP | -25.3 |
| Domestic PU-165<br><br>A-13780 | Hearth in middle use surface.<br><br>Associated with Pitrén and other sherds. Levels 6-7. | 1810 +/- 90 | 20 calBC - 420 calAD | 1970 – 1530 calBP | -25.0 |
| Domestic PU-165<br><br>AA64652 | Charcoal from burned feature in middle use surface.<br><br>Associated with Pitrén and other sherds. Levls 6-7. | 1845 +/- 40 | 50 – 250 calAD | 1900 -1700 calBP | -24.1 |
| Domestic PU-165<br><br>AA64646 | Charcoal from hearth in middle use surface.<br><br>No sherds. Base of Level 7. | 2010 +/- 40 | 120 calBC - 80calAD | 2070 -1870 calBP | -26.0 |
| Domestic PU-165<br><br>AA64658 | Charcoal in middle use surface.<br><br>No sherds. Base of Level 7 | 2530 +/- 40 | 850 – 490 calBC | 2800 – 2440 calBP | -27.0 |

*Radiocarbon dates calculated by the University of Arizona & additional calibration with *CalPal: The Köln Radiocarbon Calibration & Paleoclimate Research Package.*

# All dates are derived from wood charcoal.

**Appendix II: Sherd Rim Profiles for all types from Surface and Excavated Site Contexts and Spatial Distribution Maps for each Ceramic Type.**

The chronological periodization of excavated levels at sites PU-122, PU-132, PU-157, and PU-165 is roughly as follows: levels 1 and 2 date to the EH period; levels 2 and 4 date to the LPH period; and levels 5 through 7 date to the EPH period.

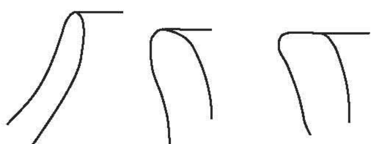


## PU-165 Bloque A, Level 2: 15-30cm

*No Type*

A-416-1 415-2-23 A-3-2-121 A-3-2-26 A-3-2-138 A-3-2-191 A-4 y 5-2-51 A-4 y 5-2-120

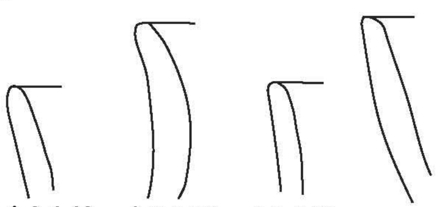
*Type 2*



A-1-2-400 A-1-2-107 A-1-2-46

## Pu-165 Bloque A, Level 3: 30-45cm

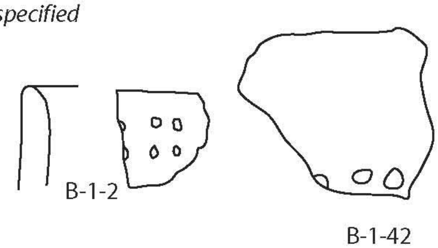
*Type 9*



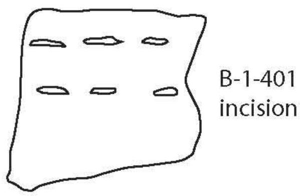
A-3-4-13 A-3-4-62 A-3-4-29 35-50 cm

## Pu-165 Bloque B, Level 1: 0-15cm

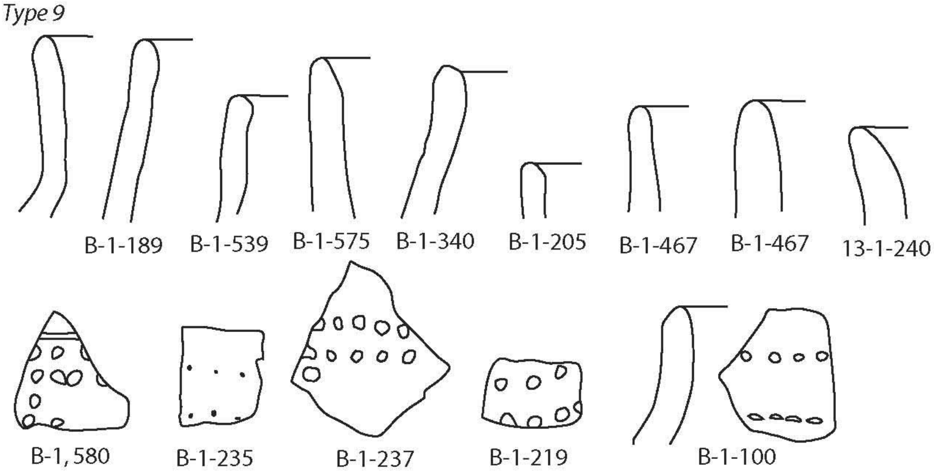
*No type specified*



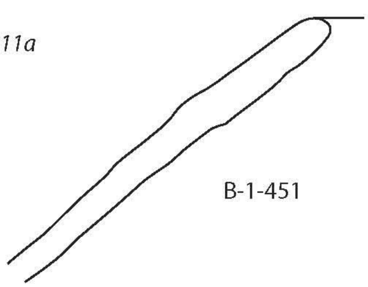

*Type 5*



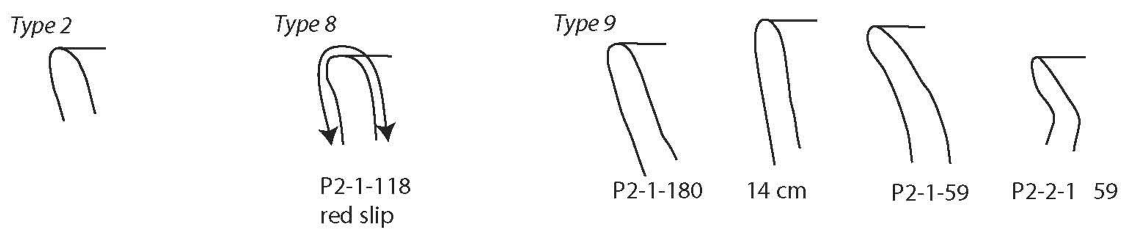

*Type 9*



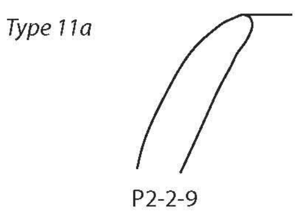

*Type 11a*



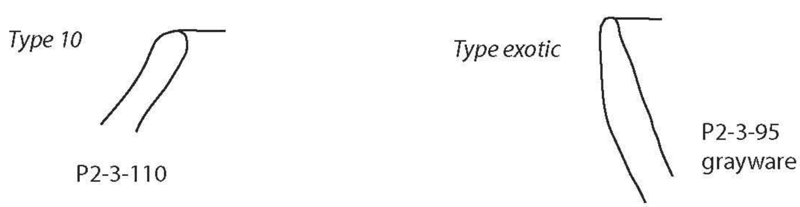
**Pu-165 Pozo 2, Level 1: 0-15cm**



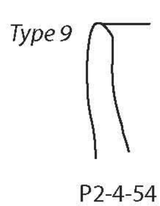

**Pu-165 Pozo 2, Level 2: 15-30cm**



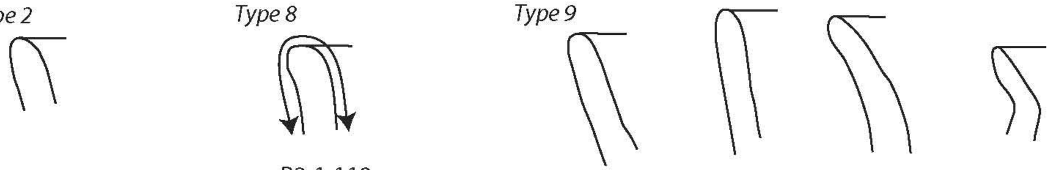

**Pu-165 Pozo 2, Level 3: 30-45cm**




**Pu-165 Pozo 2, Level 4: 45-60cm**



**Pu-165 Pozo 2, Level 1: 0-15cm**

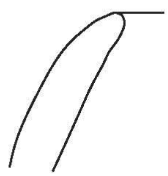


*Type 2*

*Type 8* — P2-1-118 red slip

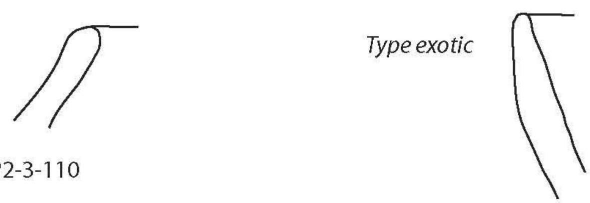
*Type 9* — P2-1-180, 14 cm, P2-1-59, P2-2-1 59

**Pu-165 Pozo 2, Level 2: 15-30cm**



*Type 11a* — P2-2-9

**Pu-165 Pozo 2, Level 3: 30-45cm**



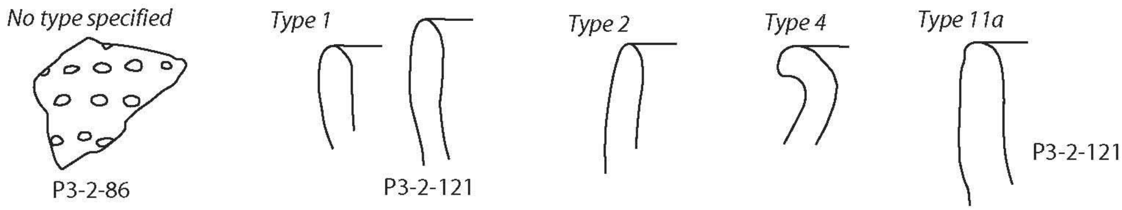
*Type 10* — P2-3-110

*Type exotic* — P2-3-95 grayware

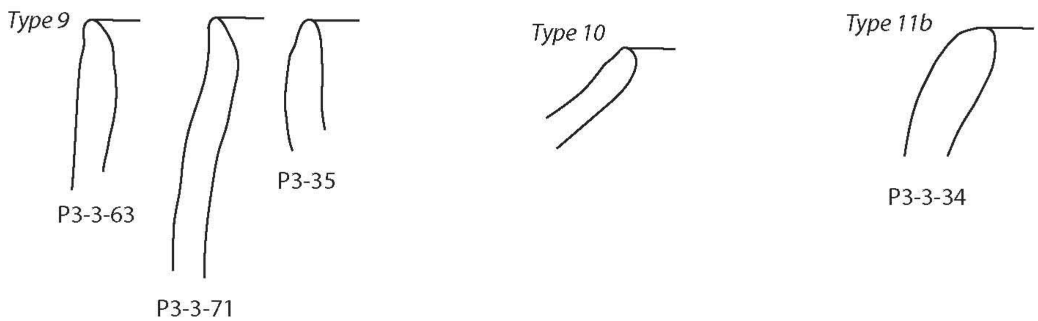
**Pu-165 Pozo 2, Level 4: 45-60cm**

*Type 9* — P2-4-54

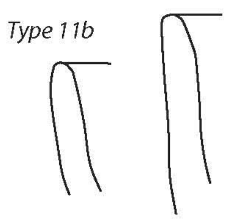
## Pu-165 Pozo 3, Level 2: 15-30cm



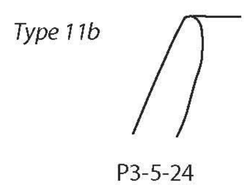

## Pu-165 Pozo 3, Level 3: 30-45cm



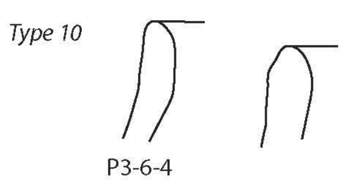

## Pu-165 Pozo 3, Level 4: 45-60cm

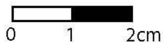



## Pu-165 Pozo 3, Level 5: 60-75cm

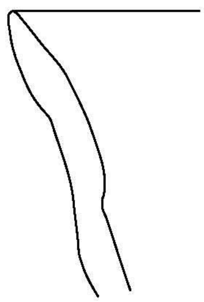



## Pu-165 Pozo 3, Level 6: 75-90cm

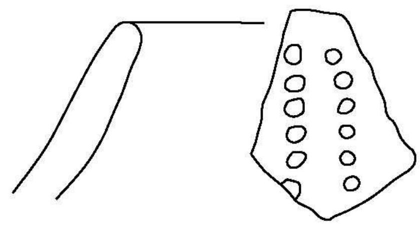




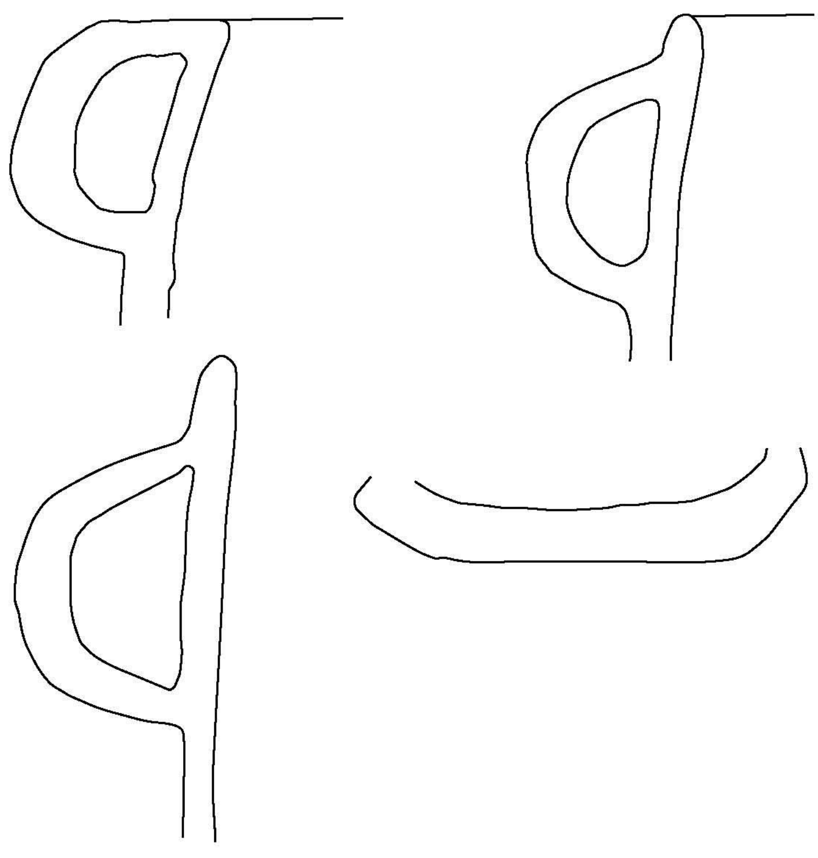

**Lu-69 Unit 1: 300-350 cm**

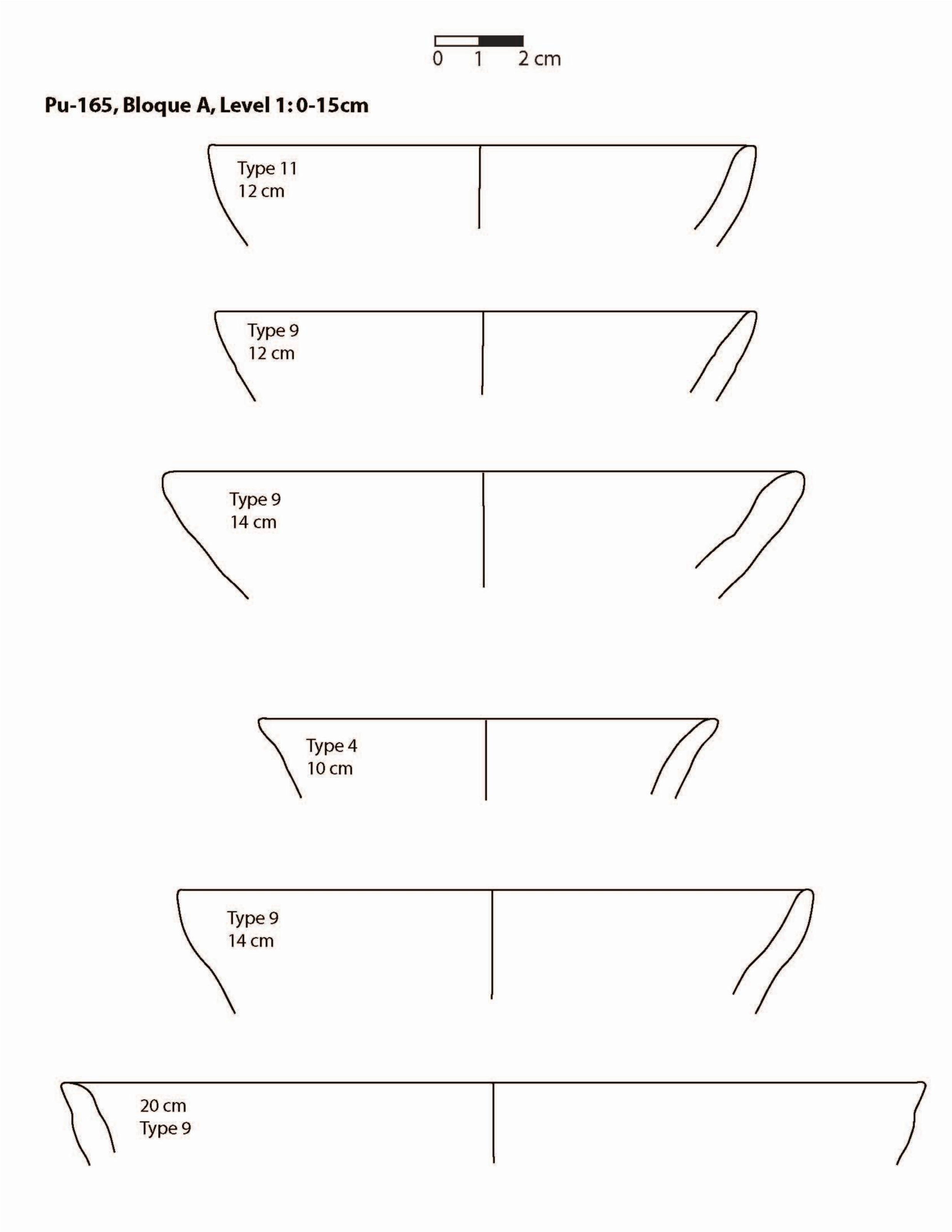


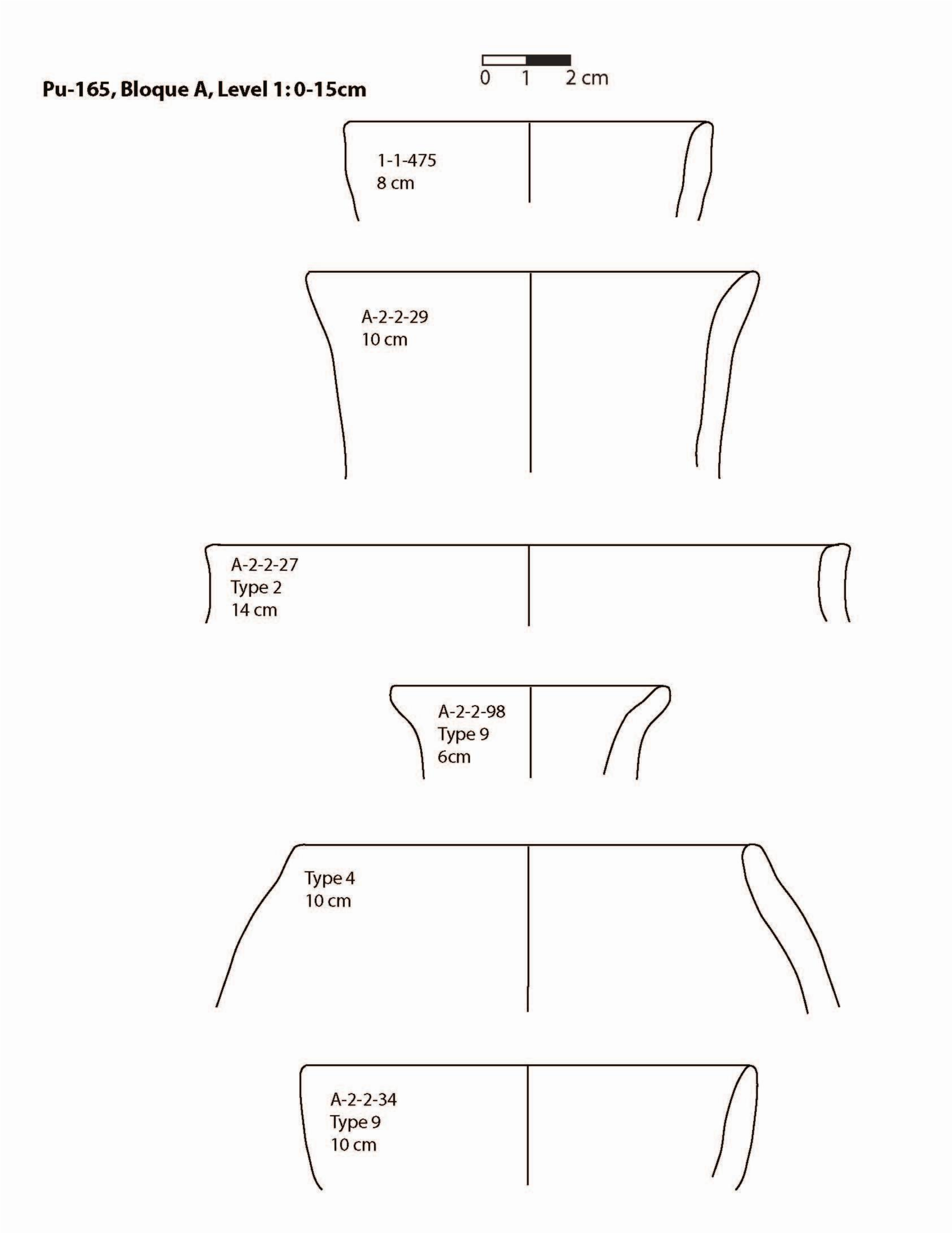
**Lu-69 Unit 5 Level 1: 0-25 cm**

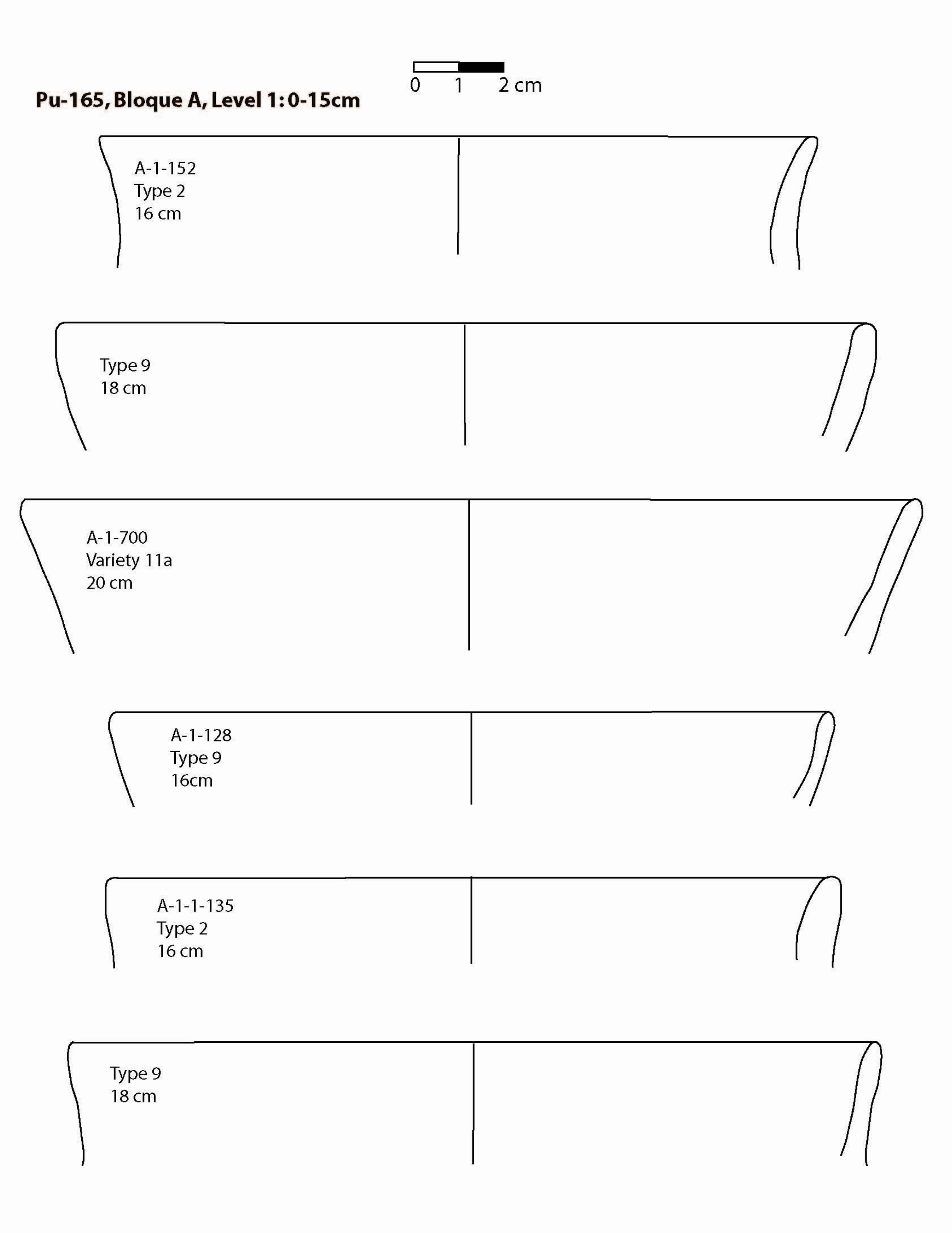


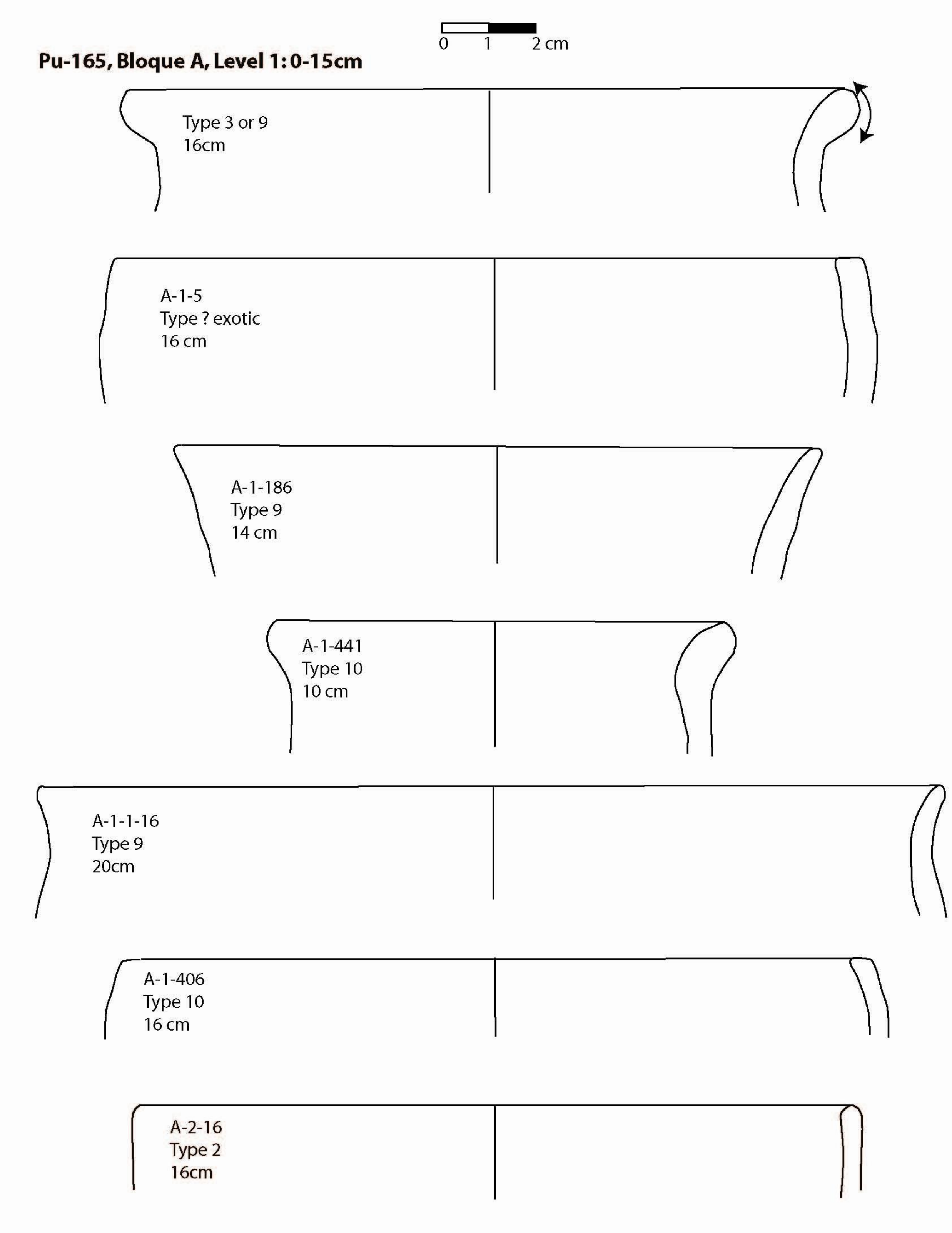
**Lu-69 Drinking Cups: Varieties 11A and 11B**



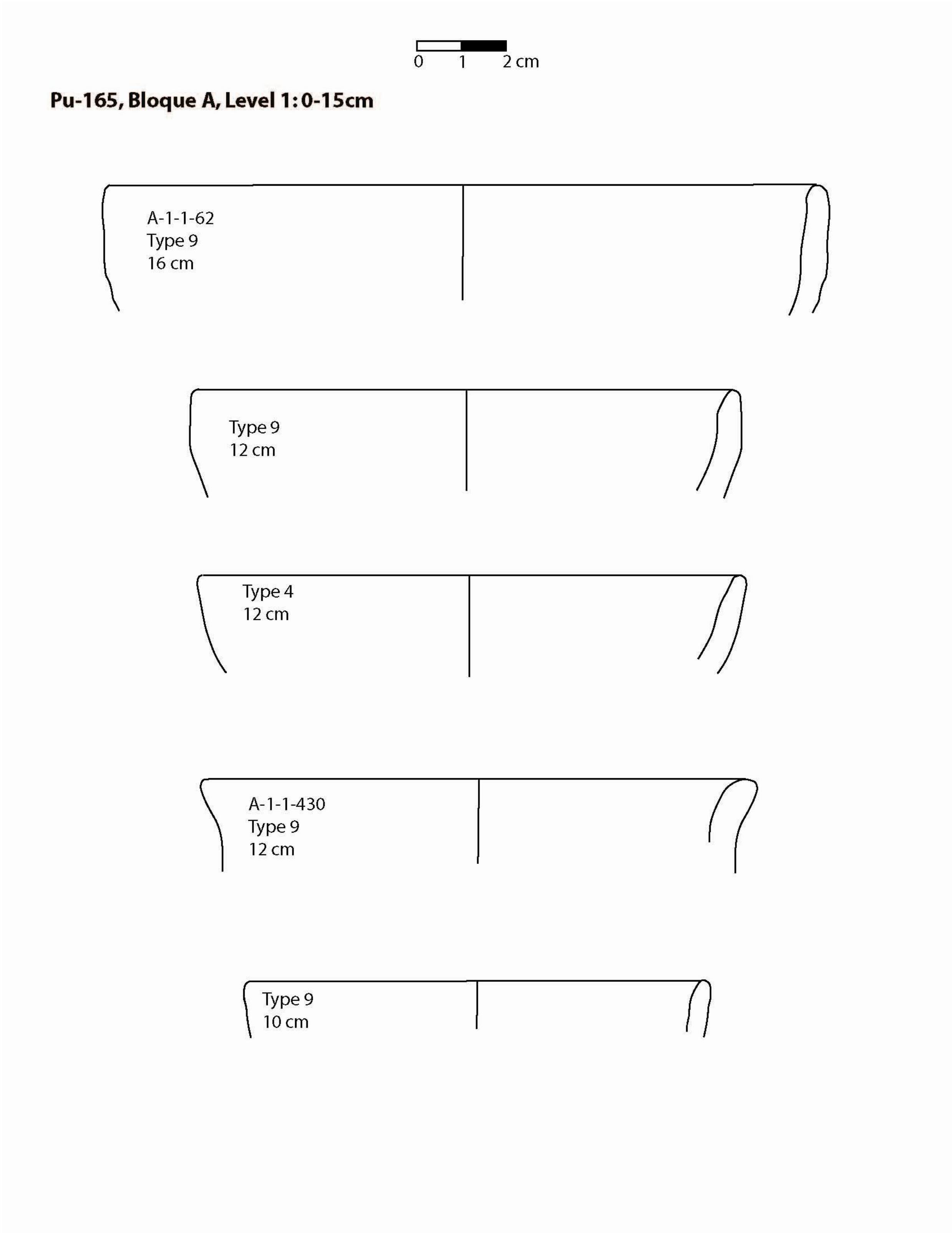

0 1 2 cm
Pu-165, Bloque A, Level 1: 0-15cm
Type 11
12 cm
Type 9
12 cm
Type 9
14 cm
Type 4
10 cm
Type 9
14 cm
20 cm
Type 9

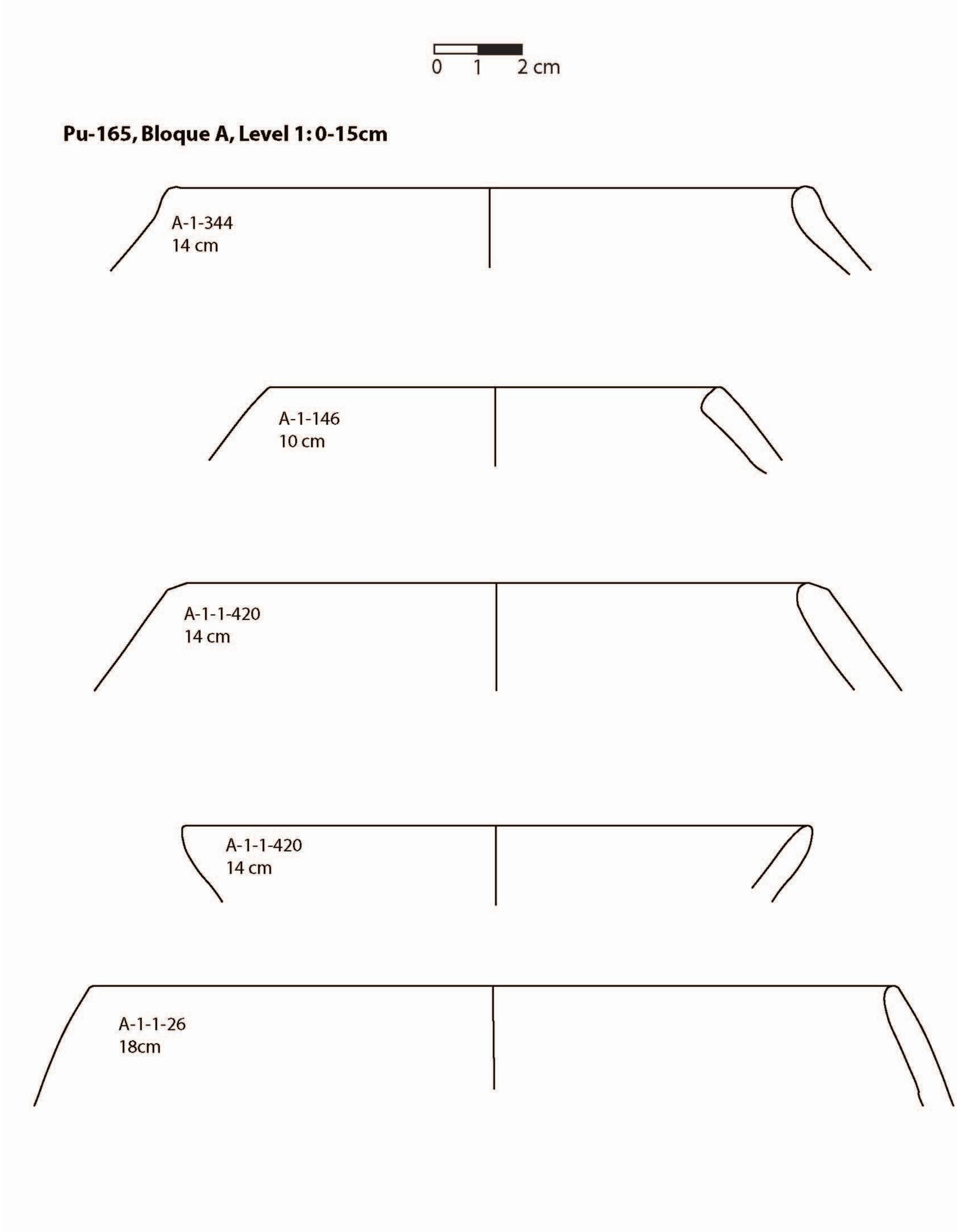

Pu-165, Bloque A, Level 1: 0-15cm
0
1
2 cm
1-1-475
8 cm
A-2-2-29
10 cm
A-2-2-27
Type 2
14 cm
A-2-2-98
Type 9
6cm
Type 4
10 cm
A-2-2-34
Type 9
10 cm

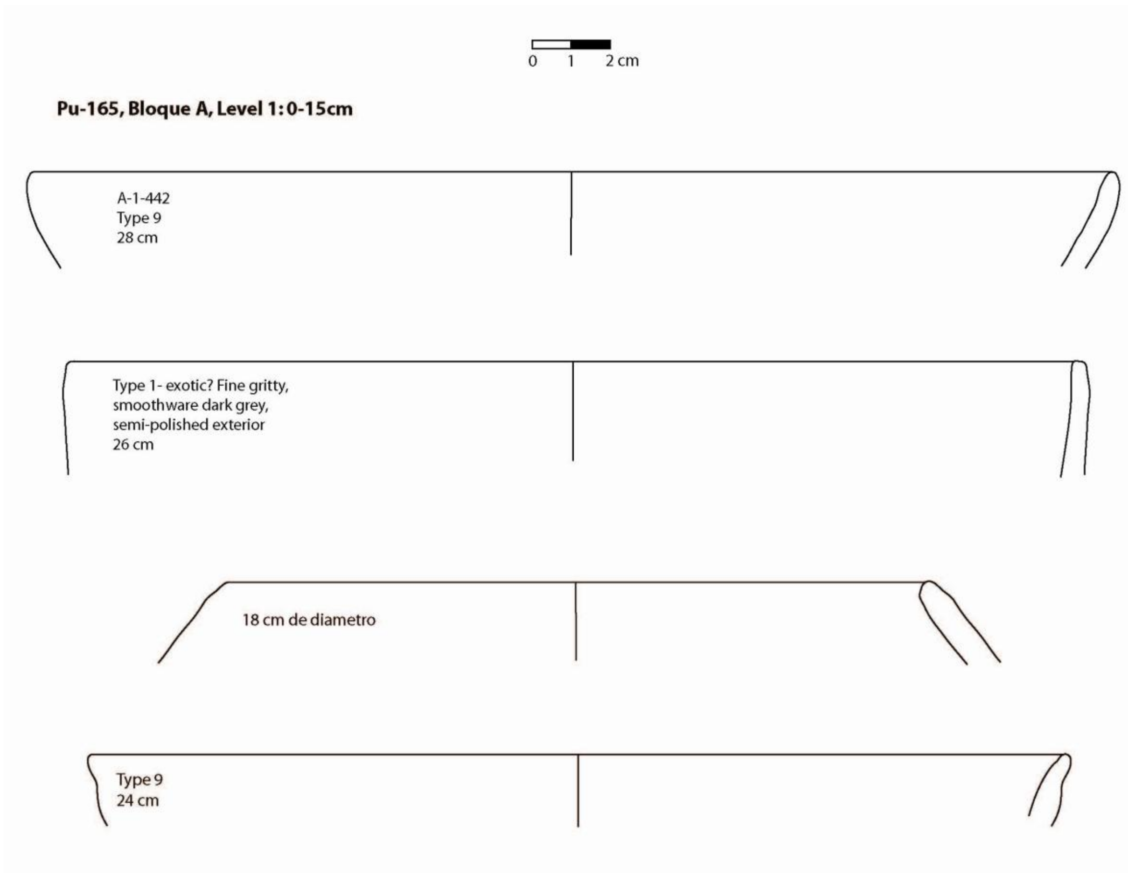

Pu-165, Bloque A, Level 1: 0-15cm
0 1 2 cm
A-1-152
Type 2
16 cm
Type 9
18 cm
A-1-700
Variety 11a
20 cm
A-1-128
Type 9
16cm
A-1-1-135
Type 2
16 cm
Type 9
18 cm

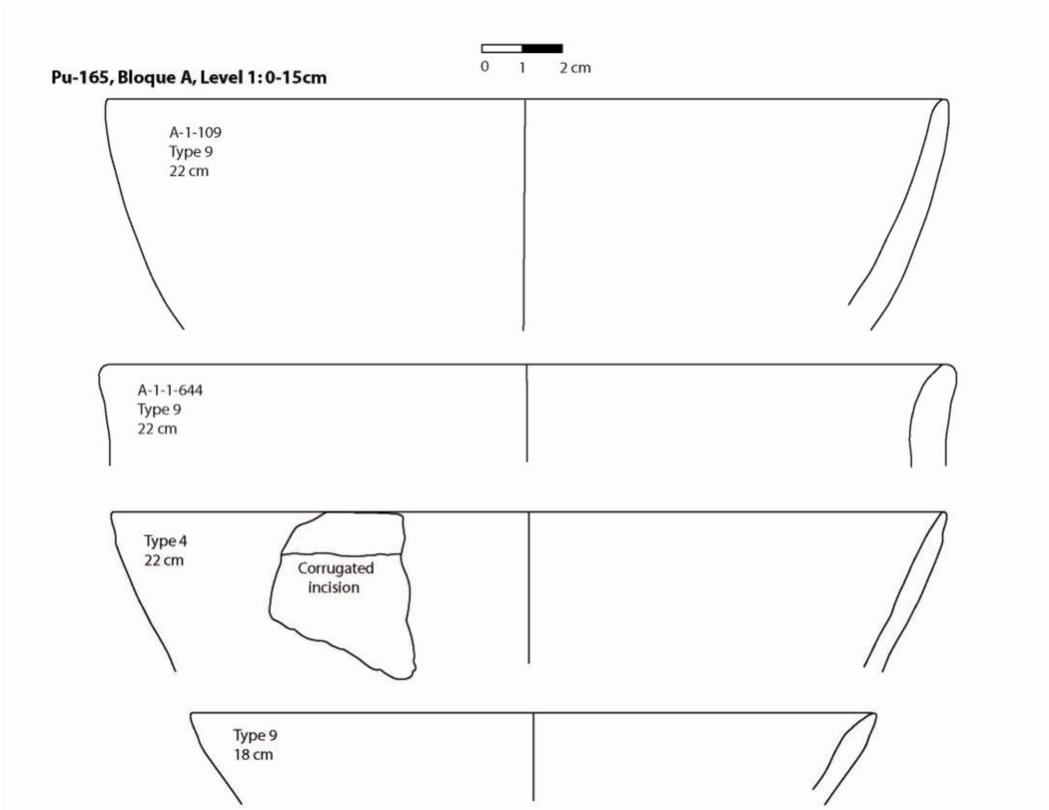


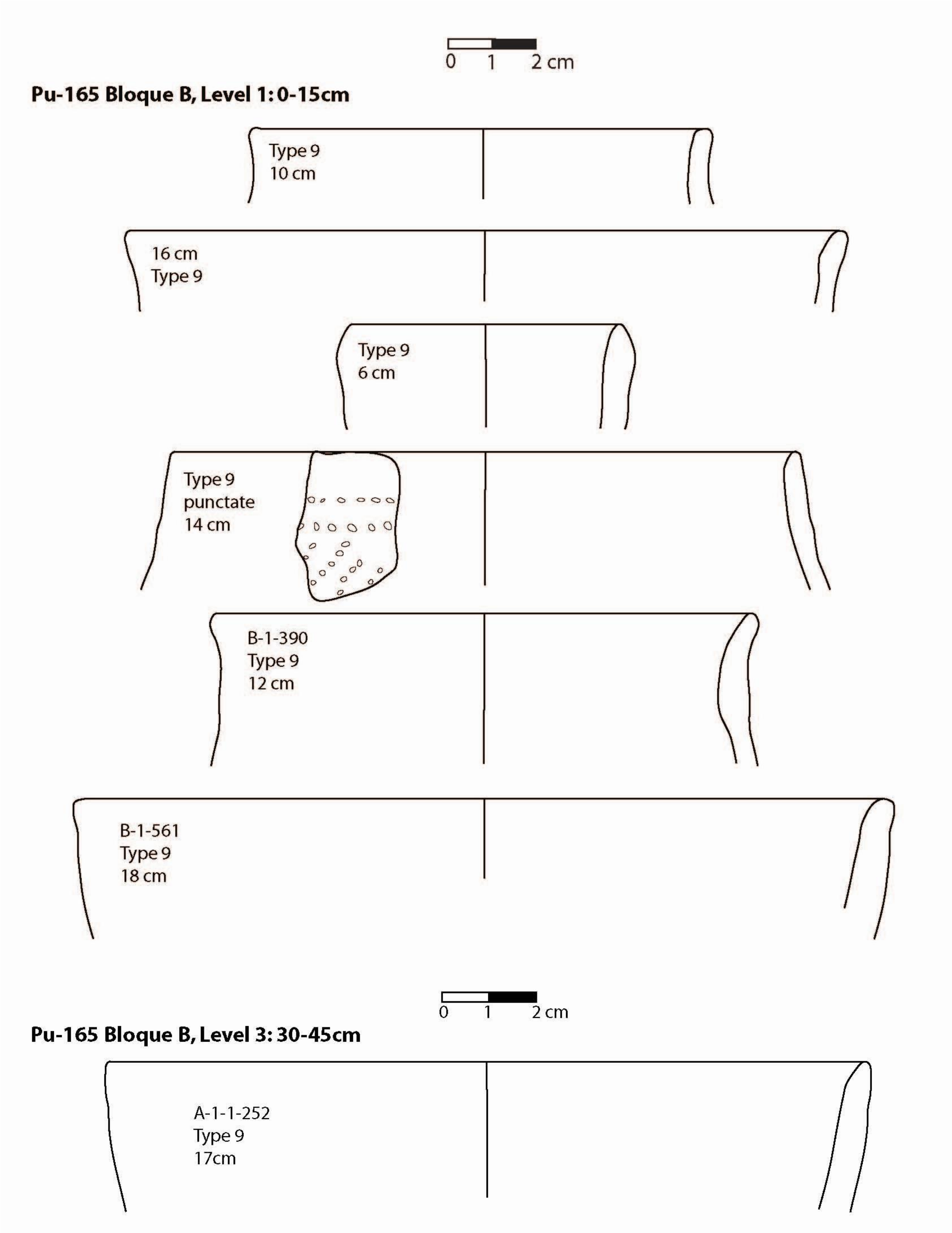
Pu-165, Bloque A, Level 1: 0-15cm
0
1
2 cm
Type 3 or 9
16cm
A-1-5
Type ? exotic
16 cm
A-1-186
Type 9
14 cm
A-1-441
Type 10
10 cm
A-1-1-16
Type 9
20cm
A-1-406
Type 10
16 cm
A-2-16
Type 2
16cm


0
1
2 cm
Pu-165, Bloque A, Level 1: 0-15cm
A-1-1-62
Type 9
16 cm
Type 9
12 cm
Type 4
12 cm
A-1-1-430
Type 9
12 cm
Type 9
10 cm


0 1 2 cm
Pu-165, Bloque A, Level 1: 0-15cm
A-1-344
14 cm
A-1-146
10 cm
A-1-1-420
14 cm
A-1-1-420
14 cm
A-1-1-26
18cm

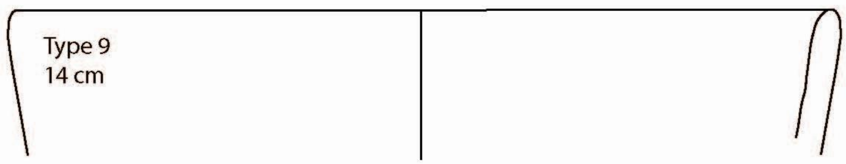

0 1 2 cm
Pu-165, Bloque A, Level 1: 0-15cm
A-1-442
Type 9
28 cm
Type 1- exotic? Fine gritty,
smoothware dark grey,
semi-polished exterior
26 cm
18 cm de diametro
Type 9
24 cm


0 1 2 cm
Pu-165, Bloque A, Level 1: 0-15cm
A-1-109
Type 9
22 cm
A-1-1-644
Type 9
22 cm
Type 4
22 cm
Corrugated
incision
Type 9
18 cm

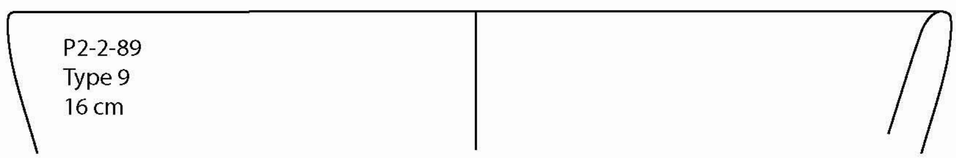

0 1 2 cm
Pu-165 Bloque B, Level 1: 0-15cm
Type 9
10 cm
16 cm
Type 9
Type 9
6 cm
Type 9
punctate
14 cm
B-1-390
Type 9
12 cm
B-1-561
Type 9
18 cm
0 1 2 cm
Pu-165 Bloque B, Level 3: 30-45cm
A-1-1-252
Type 9
17cm

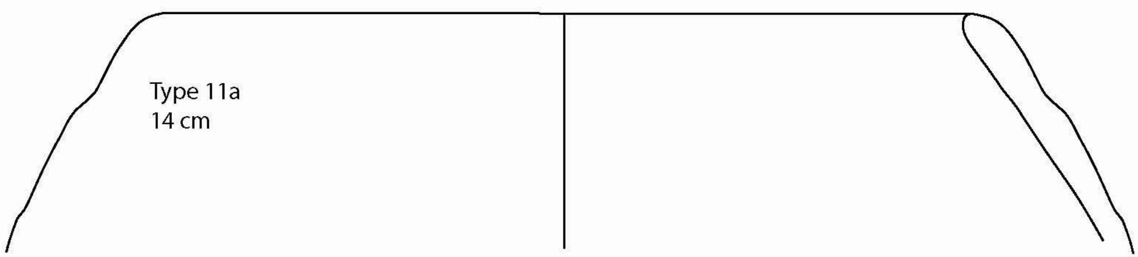
estimated scale

**Pu-165 Pozo 2, Level 1:0-15cm**

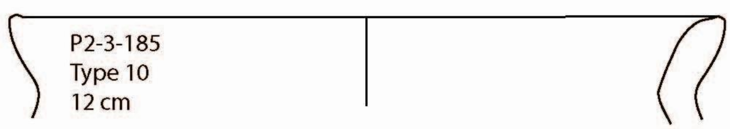


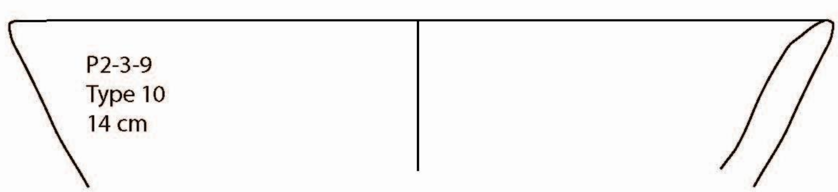

**Pu-165 Pozo 2, Level 2: 15-30cm**

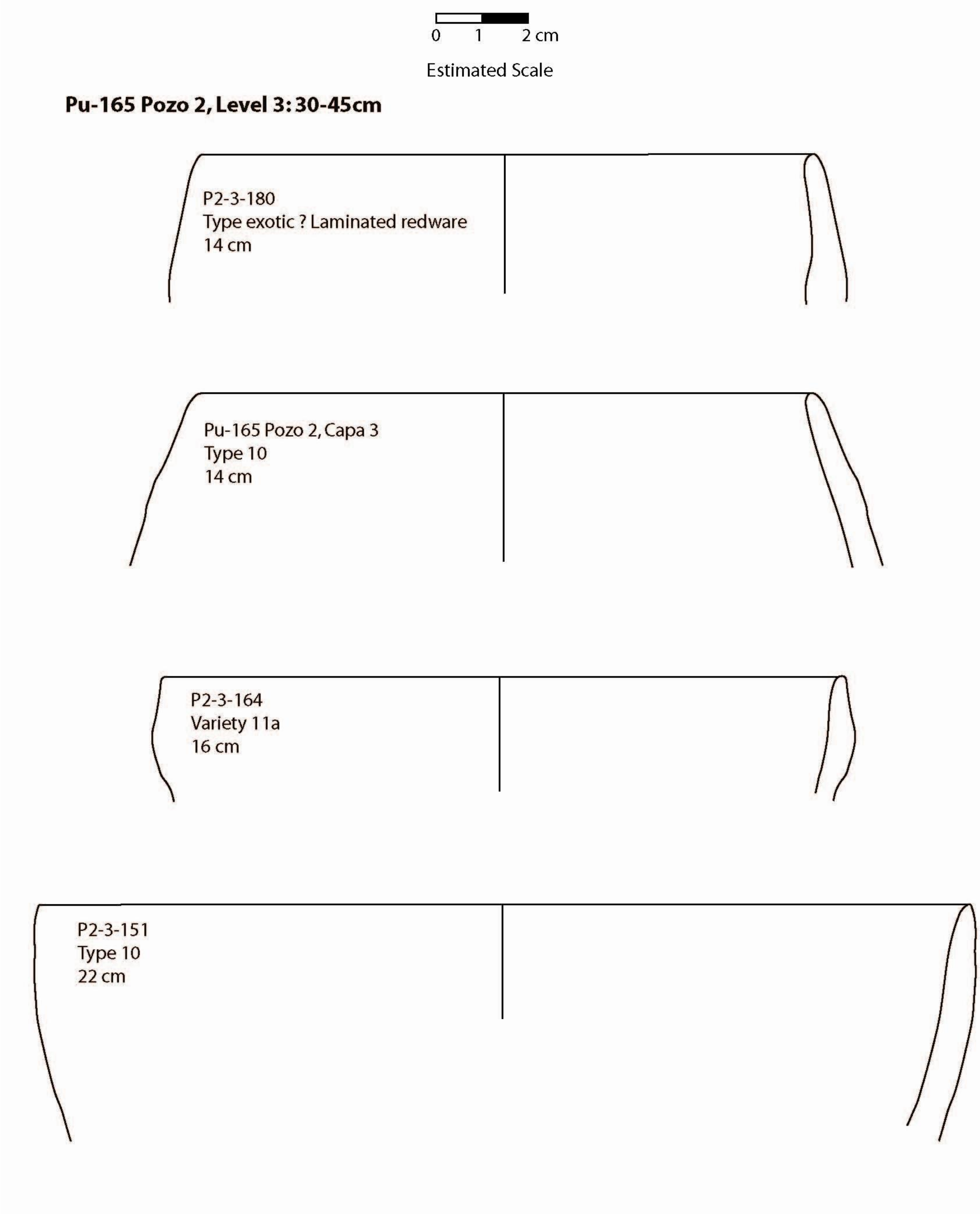


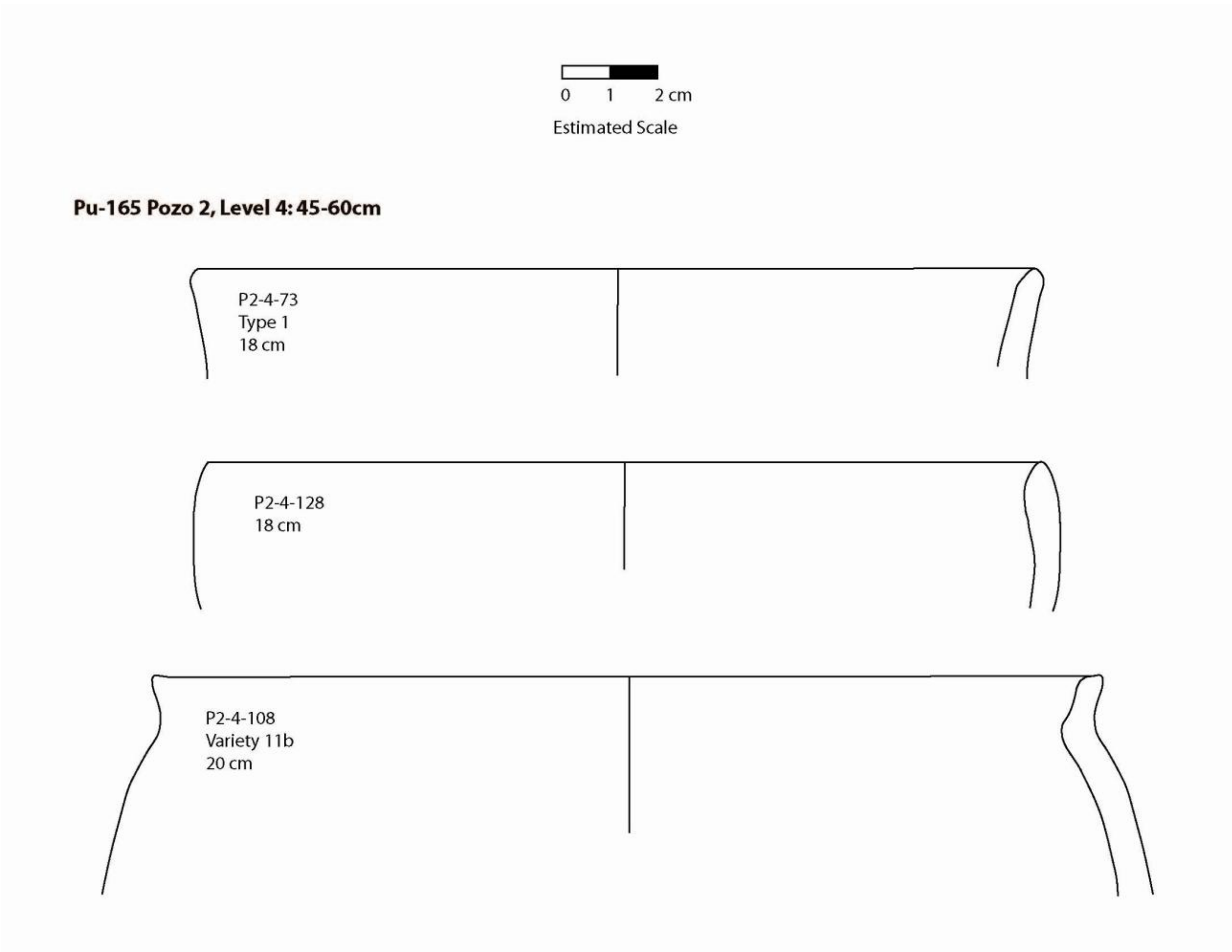




**Pu-165 Pozo 2, Level 3: 30-45cm**



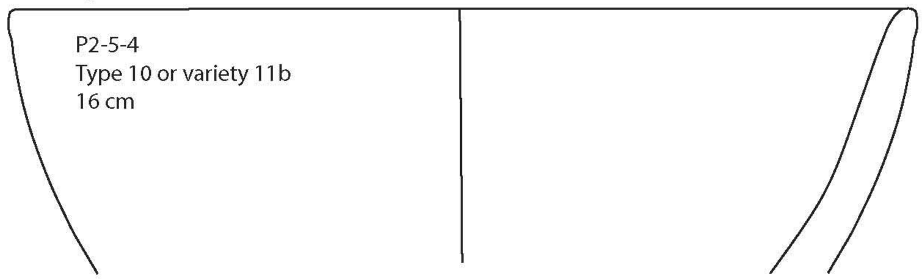




0 1 2 cm
Estimated Scale
Pu-165 Pozo 2, Level 3: 30-45cm
P2-3-180
Type exotic ? Laminated redware
14 cm
Pu-165 Pozo 2, Capa 3
Type 10
14 cm
P2-3-164
Variety 11a
16 cm
P2-3-151
Type 10
22 cm

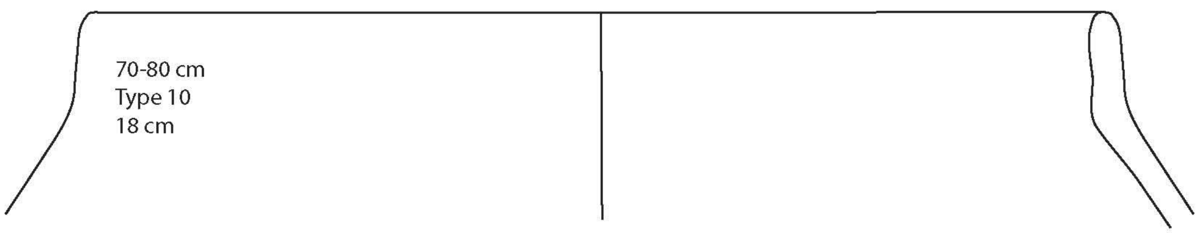

0 1 2 cm
Estimated Scale
Pu-165 Pozo 2, Level 4: 45-60cm
P2-4-73
Type 1
18 cm
P2-4-128
18 cm
P2-4-108
Variety 11b
20 cm


estimated scale

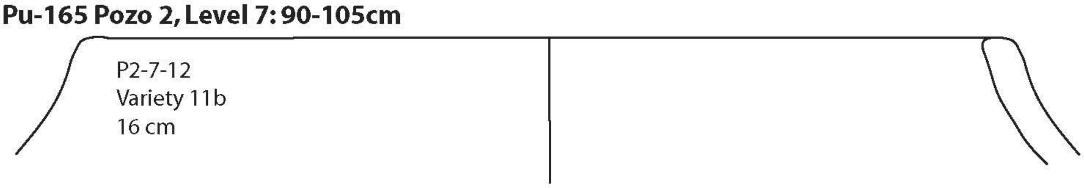
**Pu-165 Pozo 2, Level 5: 60-75cm**



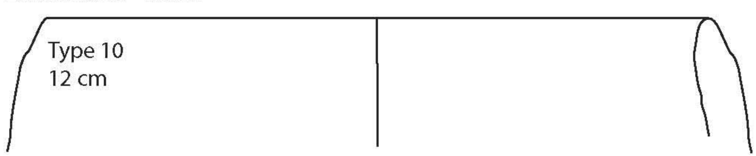

**Pu-165 Pozo 2, Level 6: 75-90cm**

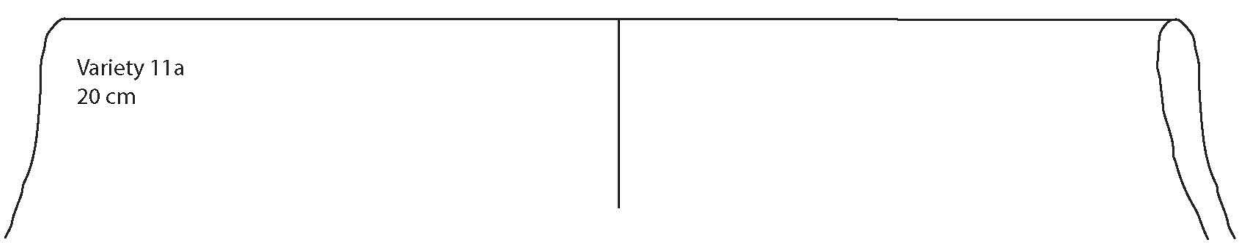


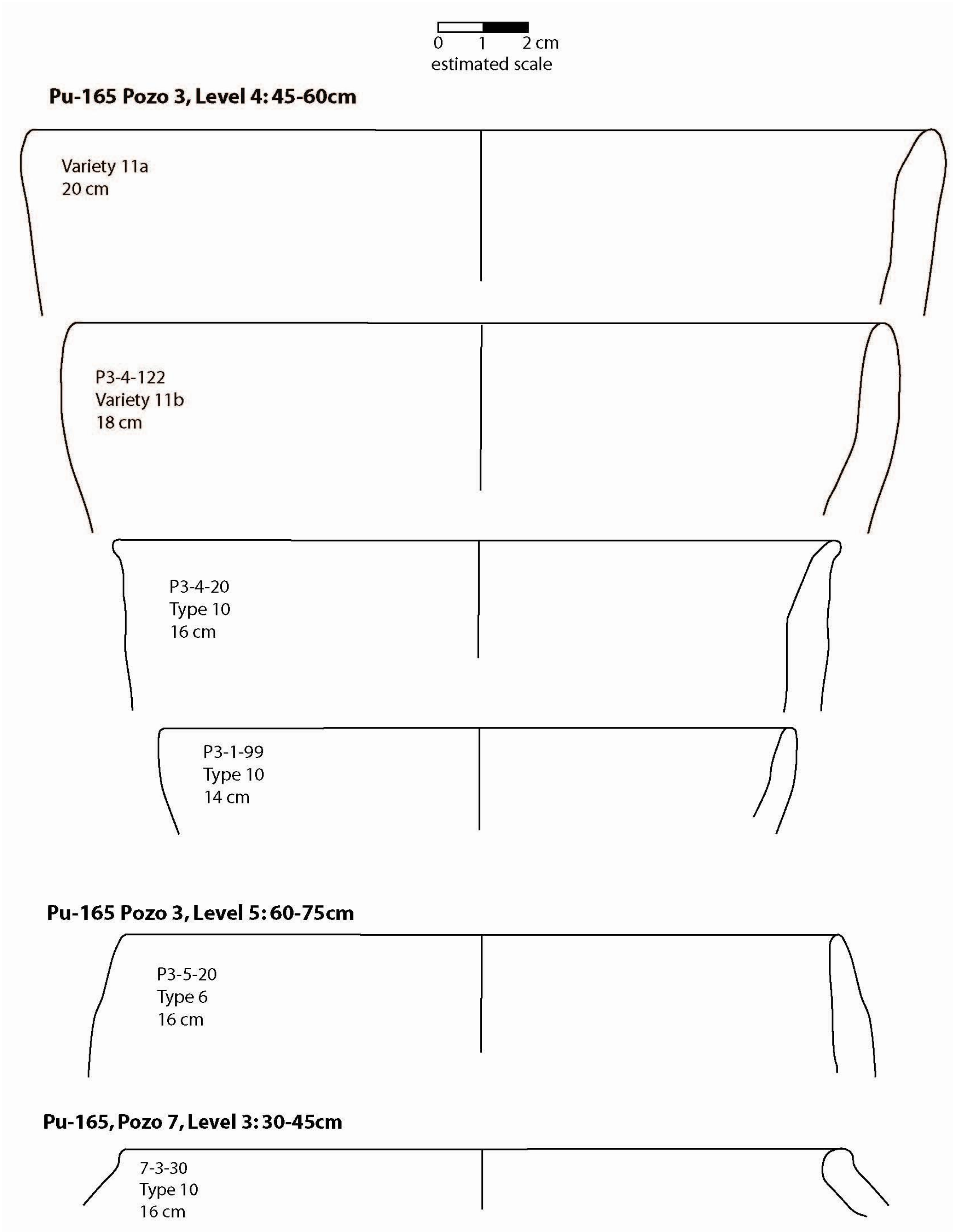

**Pu-165 Pozo 2, Level 7: 90-105cm**

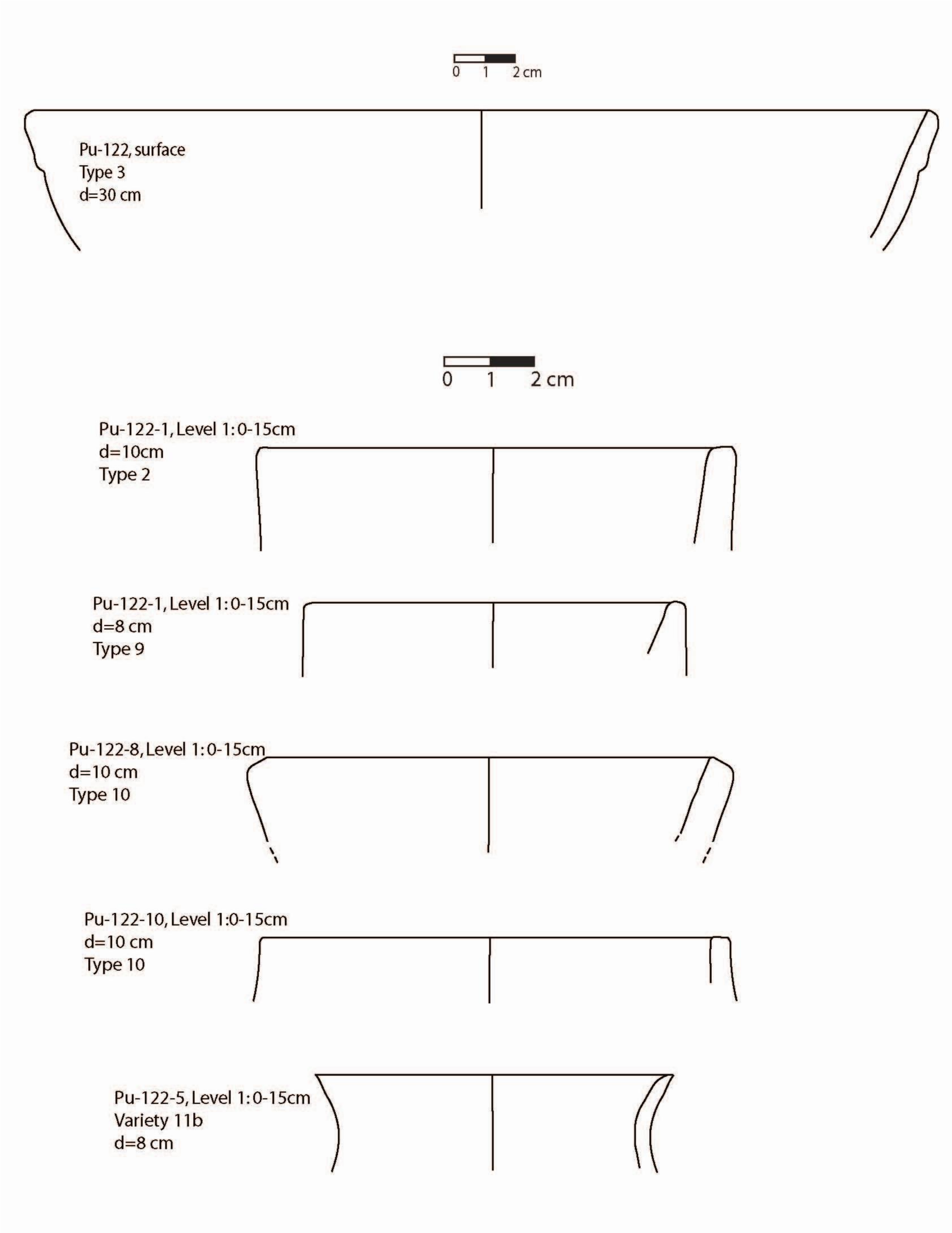


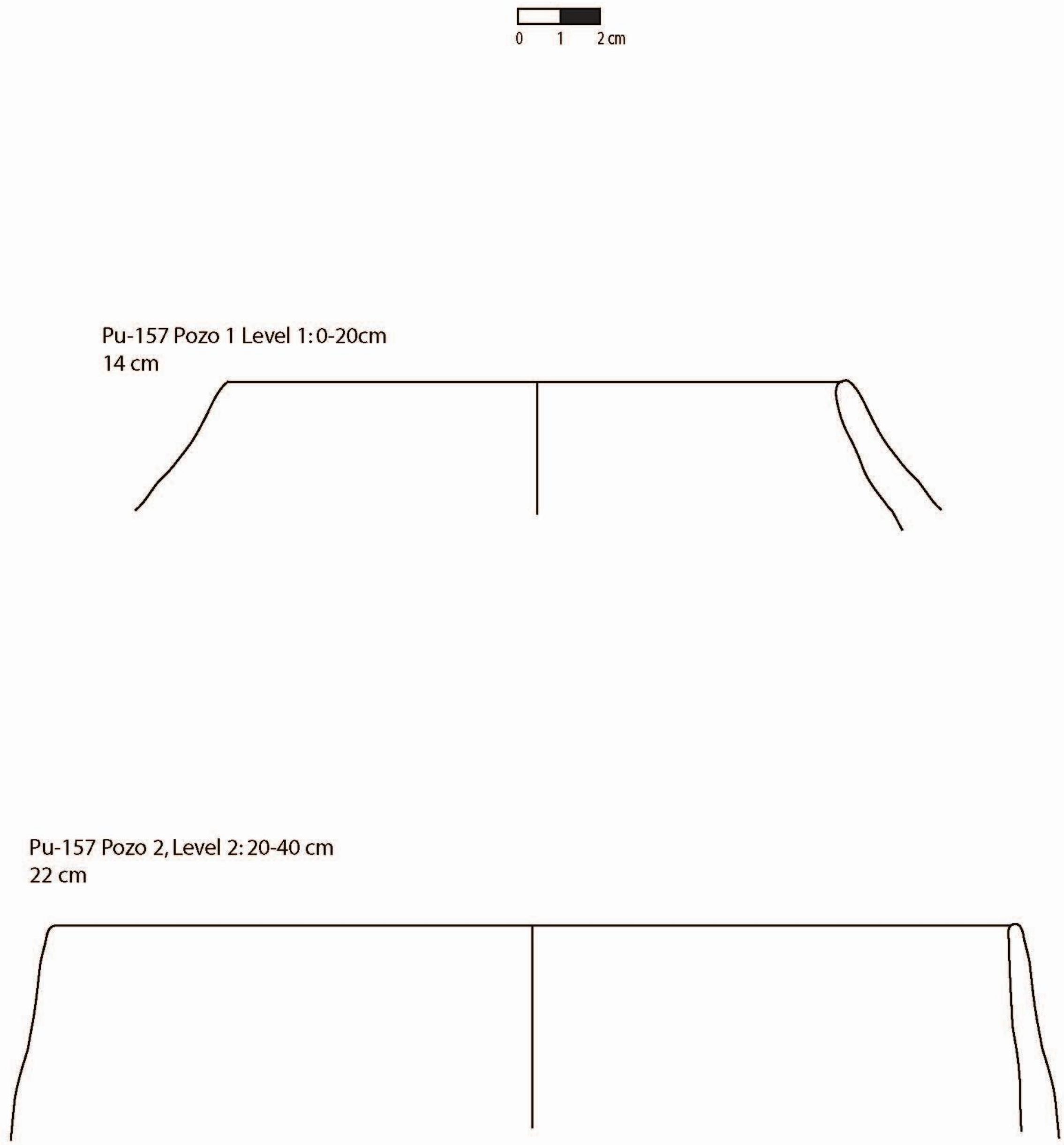

**Pu-165 Pozo 3, Level 3: 30-45cm**

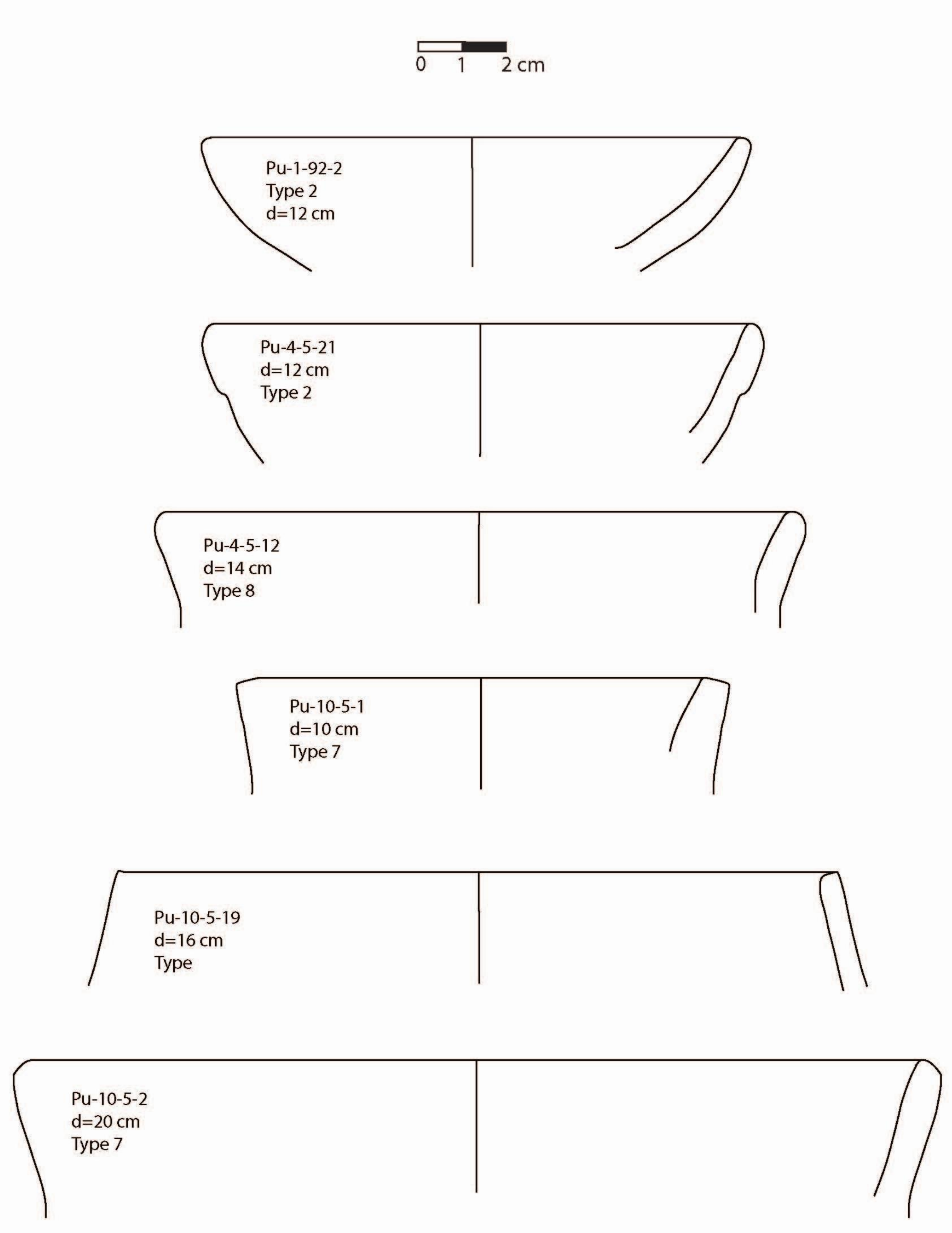


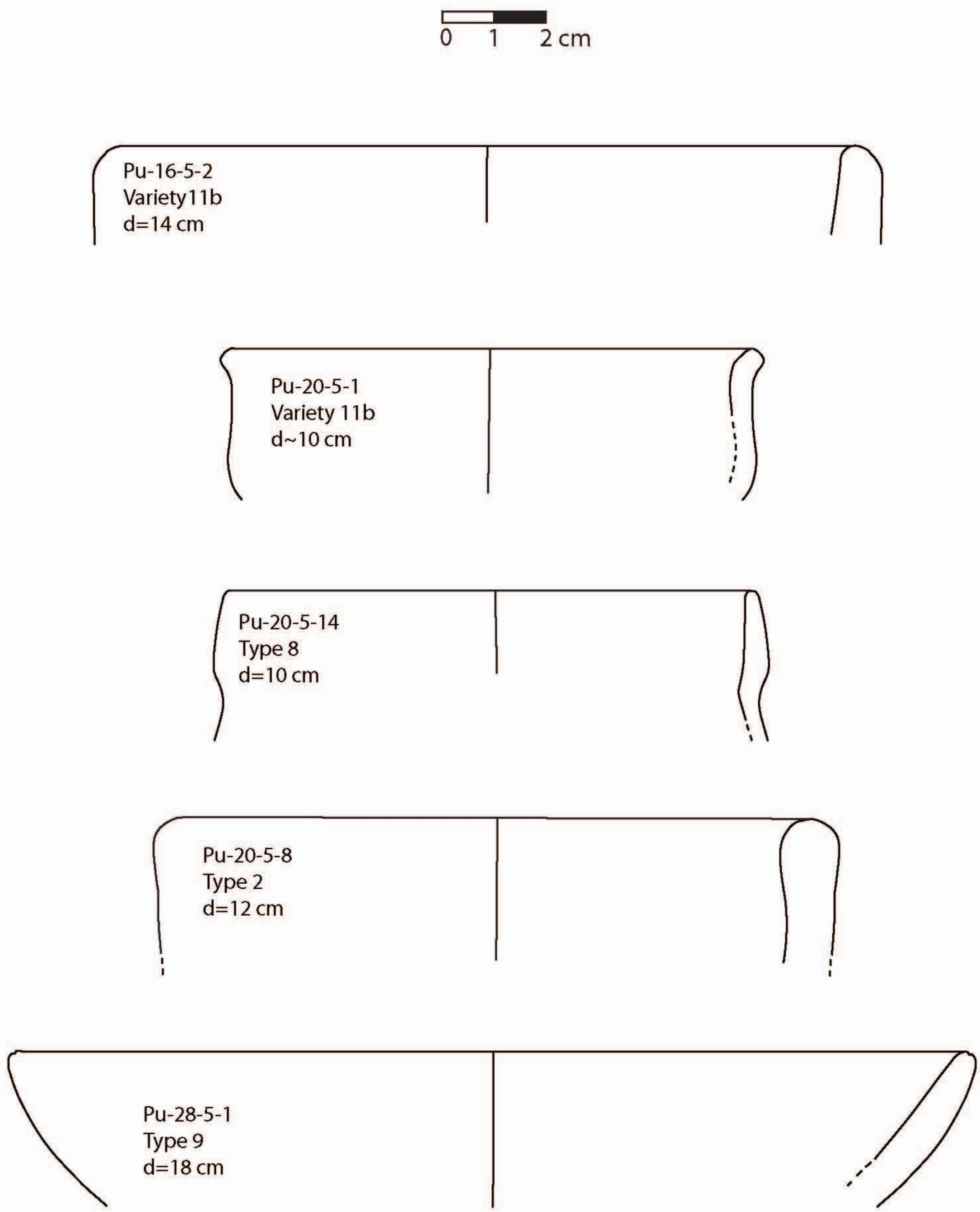



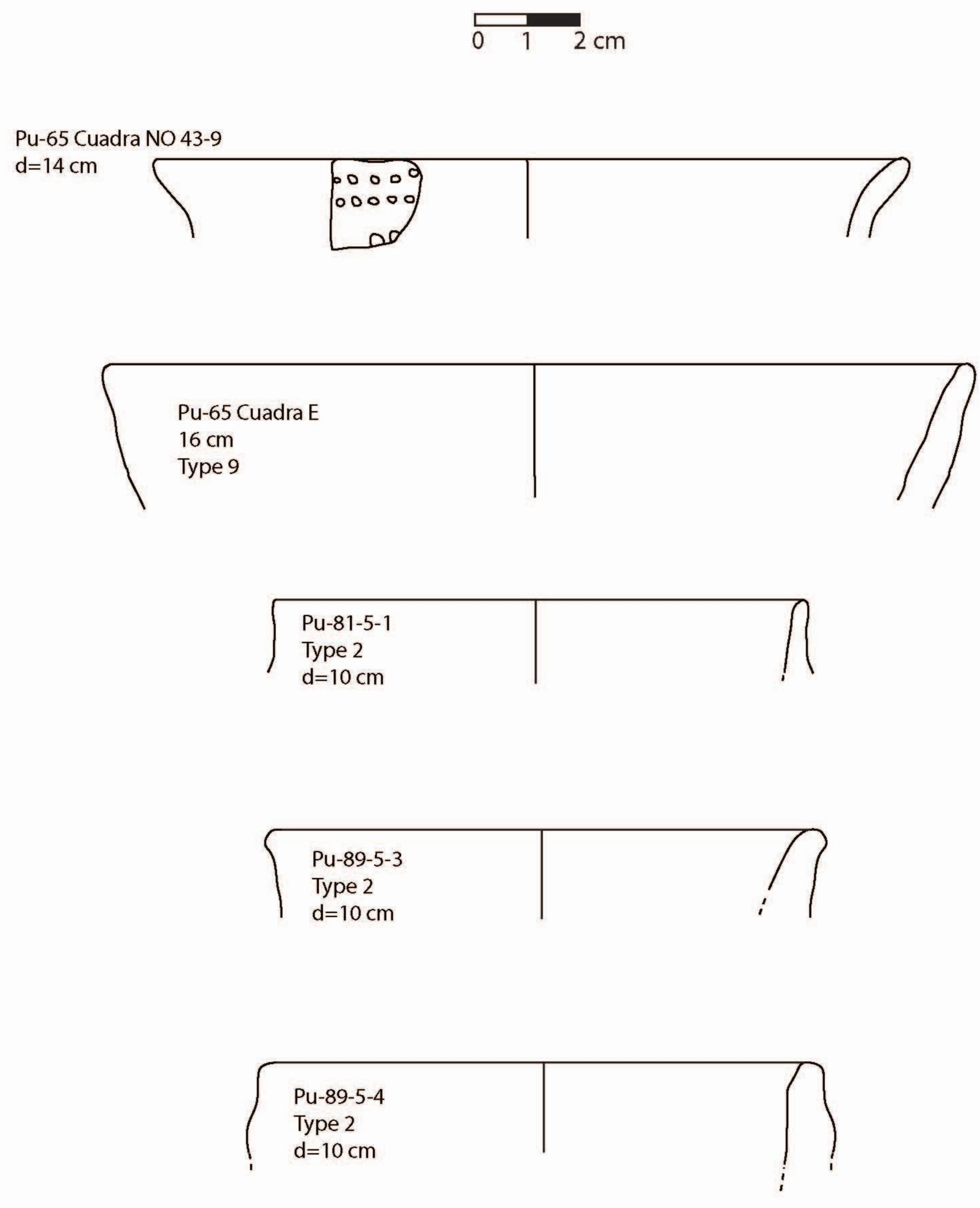

0 1 2 cm
estimated scale
Pu-165 Pozo 3, Level 4: 45-60cm
Variety 11a
20 cm
P3-4-122
Variety 11b
18 cm
P3-4-20
Type 10
16 cm
P3-1-99
Type 10
14 cm
Pu-165 Pozo 3, Level 5: 60-75cm
P3-5-20
Type 6
16 cm
Pu-165, Pozo 7, Level 3: 30-45cm
7-3-30
Type 10
16 cm


0 1 2 cm
Pu-122, surface
Type 3
d=30 cm
0 1 2 cm
Pu-122-1, Level 1: 0-15cm
d=10cm
Type 2
Pu-122-1, Level 1: 0-15cm
d=8 cm
Type 9
Pu-122-8, Level 1: 0-15cm
d=10 cm
Type 10
Pu-122-10, Level 1:0-15cm
d=10 cm
Type 10
Pu-122-5, Level 1: 0-15cm
Variety 11b
d=8 cm

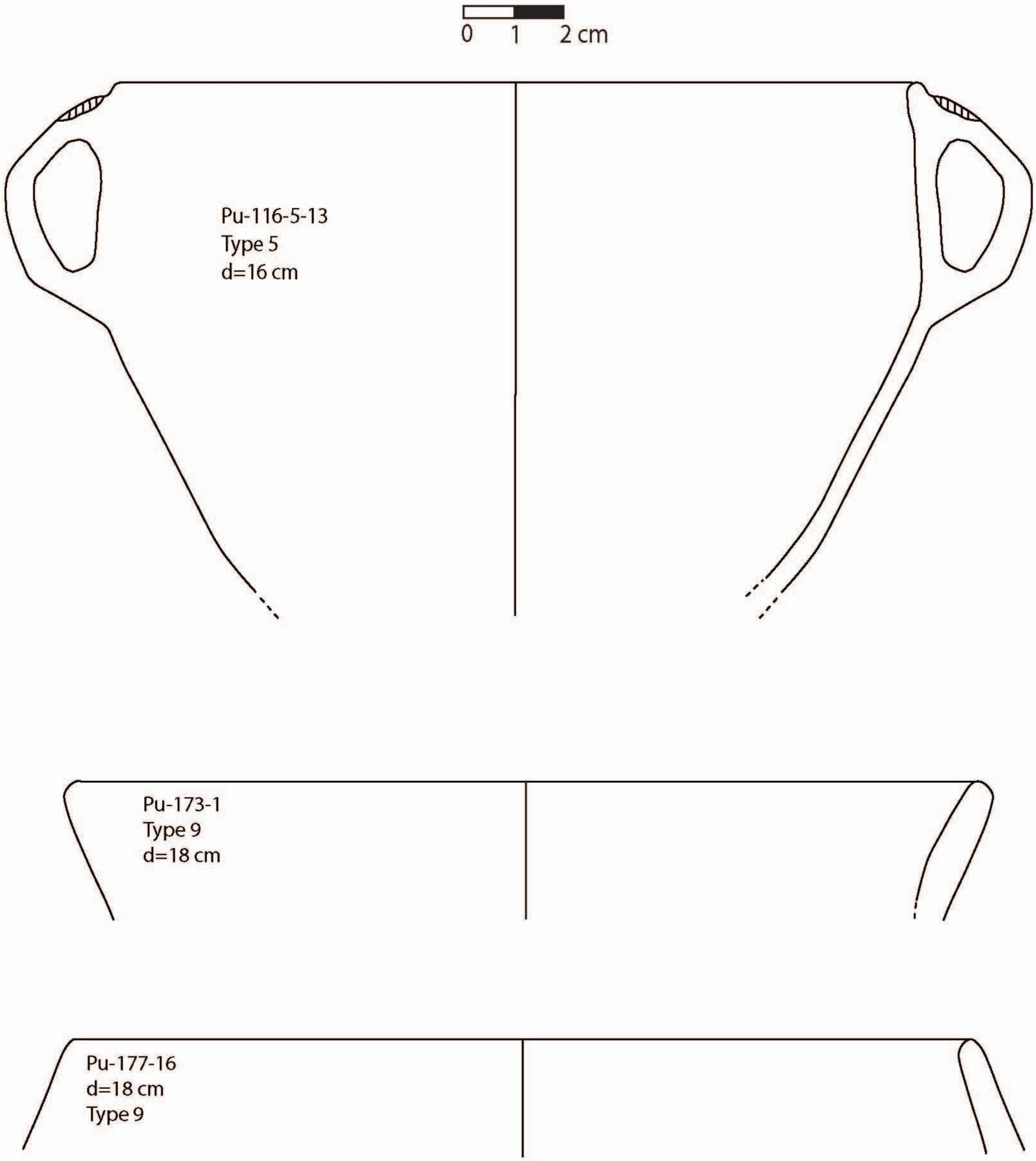

0 1 2 cm
Pu-157 Pozo 1 Level 1: 0-20cm
14 cm
Pu-157 Pozo 2, Level 2: 20-40 cm
22 cm

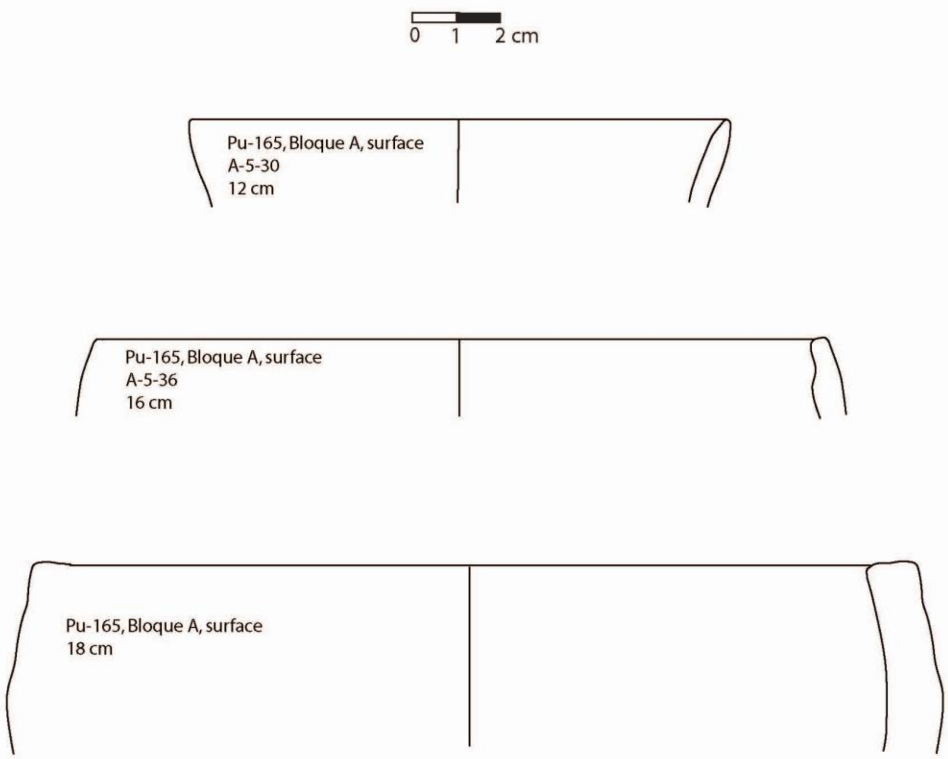

0 1 2 cm
Pu-1-92-2
Type 2
d=12 cm
Pu-4-5-21
d=12 cm
Type 2
Pu-4-5-12
d=14 cm
Type 8
Pu-10-5-1
d=10 cm
Type 7
Pu-10-5-19
d=16 cm
Type
Pu-10-5-2
d=20 cm
Type 7

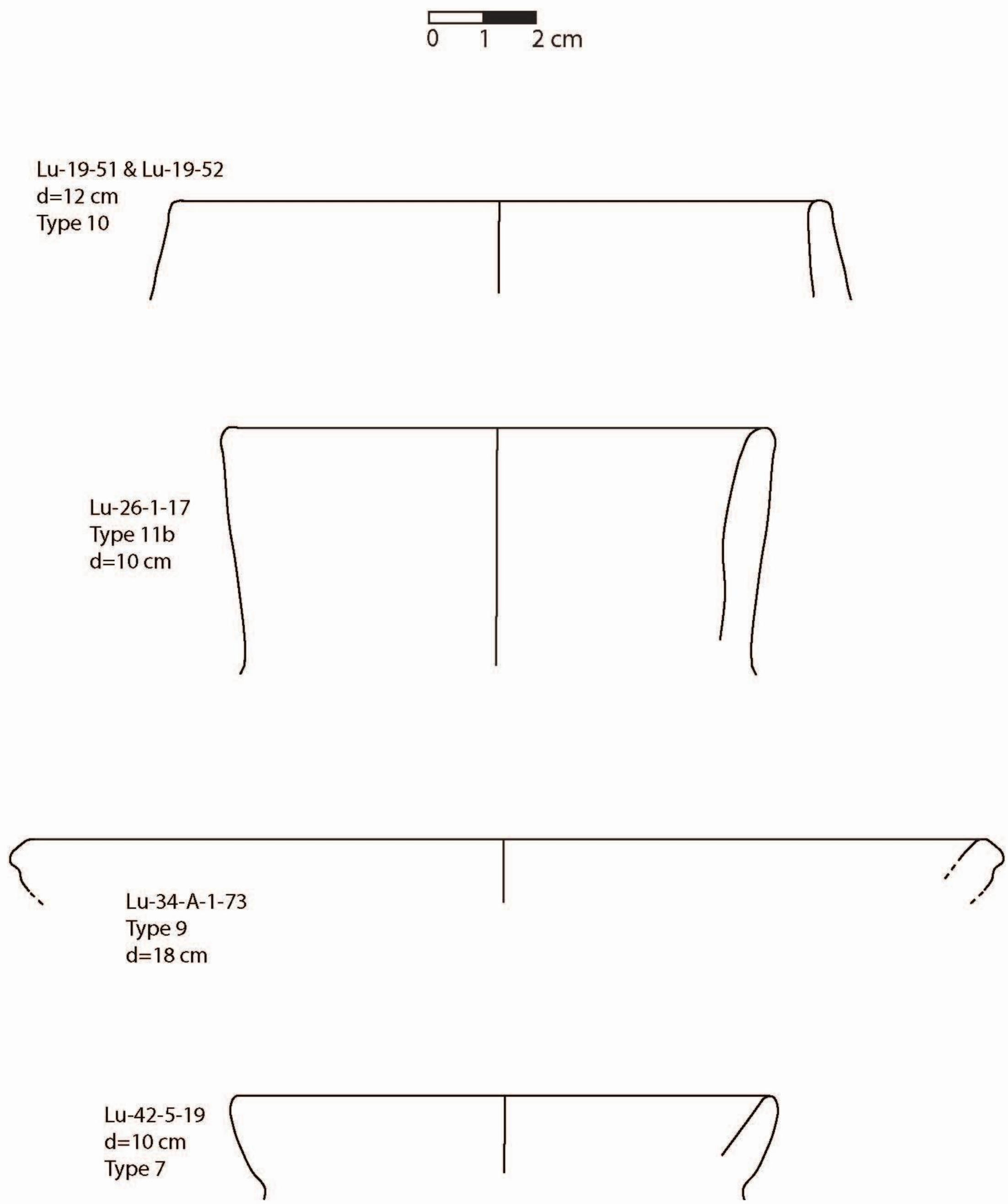

0 1 2 cm
Pu-16-5-2
Variety11b
d=14 cm
Pu-20-5-1
Variety 11b
d~10 cm
Pu-20-5-14
Type 8
d=10 cm
Pu-20-5-8
Type 2
d=12 cm
Pu-28-5-1
Type 9
d=18 cm

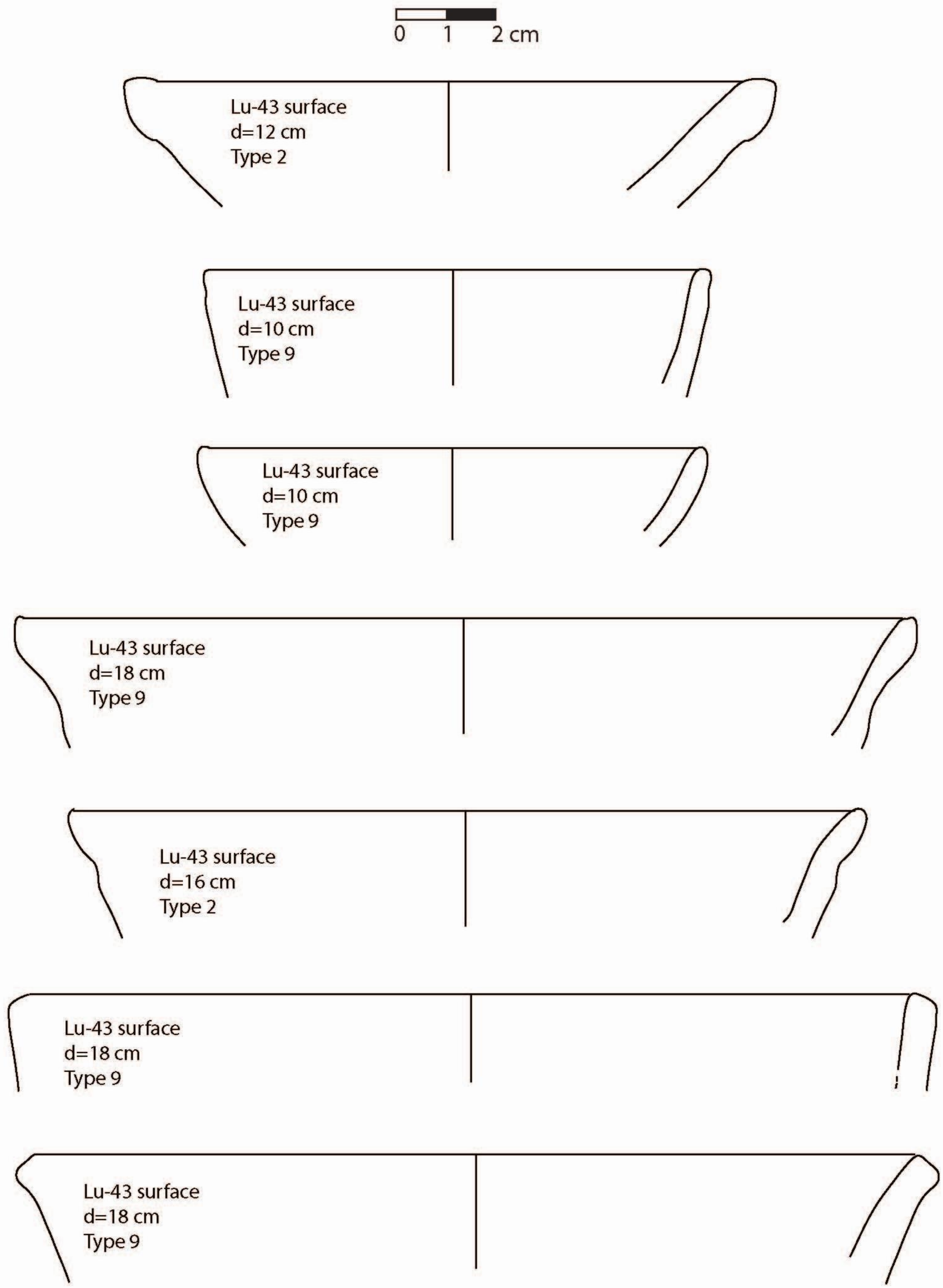


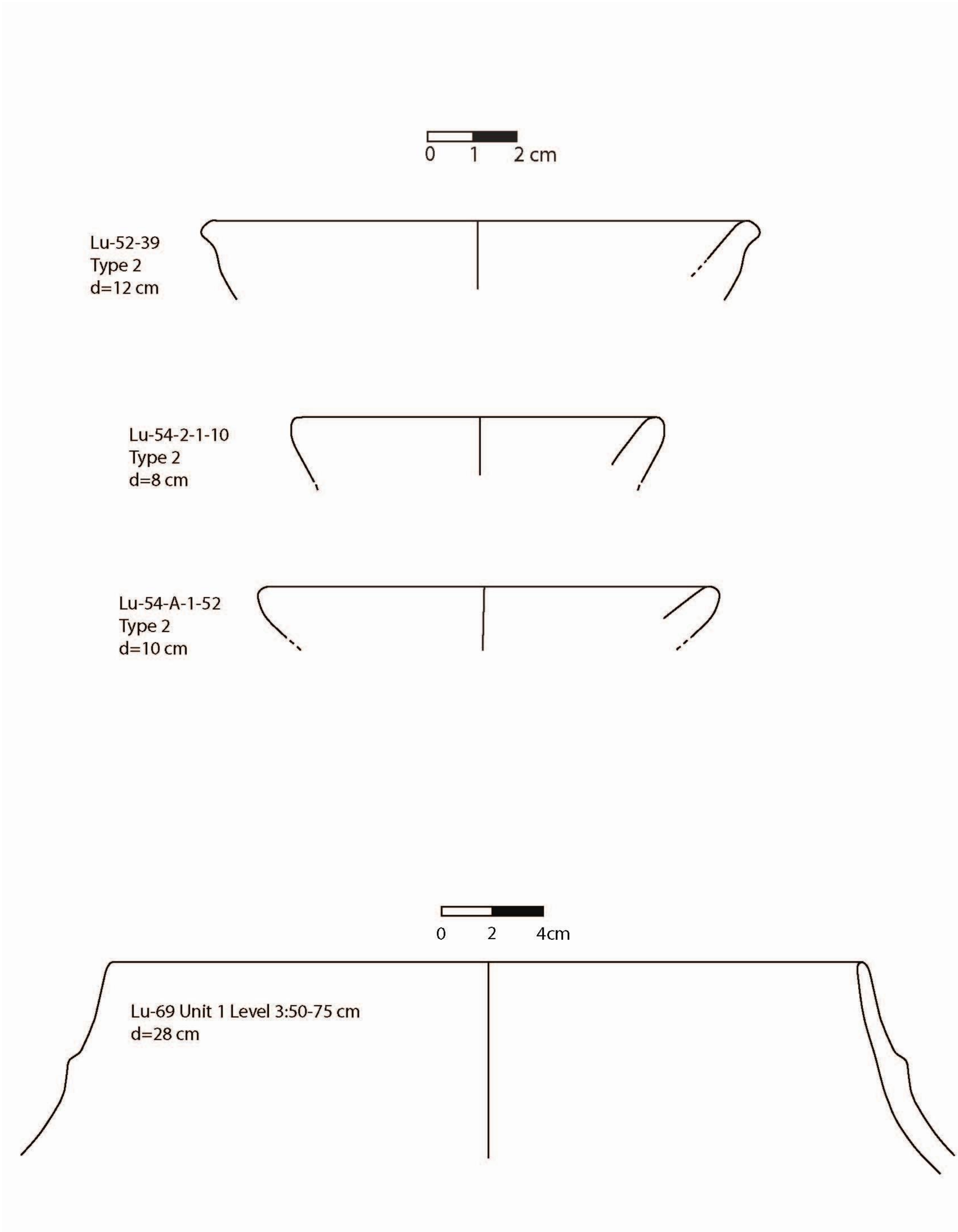
0 1 2 cm
Pu-65 Cuadra NO 43-9
d=14 cm
Pu-65 Cuadra E
16 cm
Type 9
Pu-81-5-1
Type 2
d=10 cm
Pu-89-5-3
Type 2
d=10 cm
Pu-89-5-4
Type 2
d=10 cm


0 1 2 cm
Pu-116-5-13
Type 5
d=16 cm
Pu-173-1
Type 9
d=18 cm
Pu-177-16
d=18 cm
Type 9

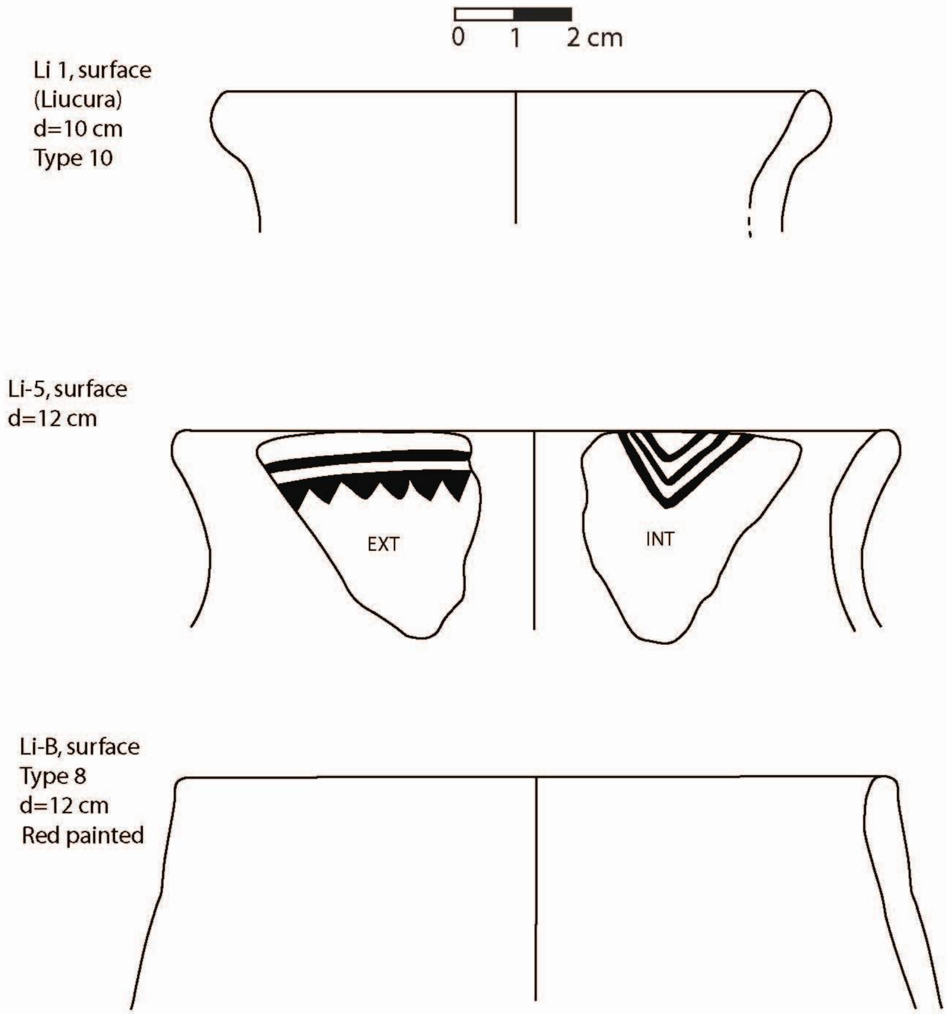

0 1 2 cm
Pu-165, Bloque A, surface
A-5-30
12 cm
Pu-165, Bloque A, surface
A-5-36
16 cm
Pu-165, Bloque A, surface
18 cm


0 1 2 cm
Lu-19-51 & Lu-19-52
d=12 cm
Type 10
Lu-26-1-17
Type 11b
d=10 cm
Lu-34-A-1-73
Type 9
d=18 cm
Lu-42-5-19
d=10 cm
Type 7

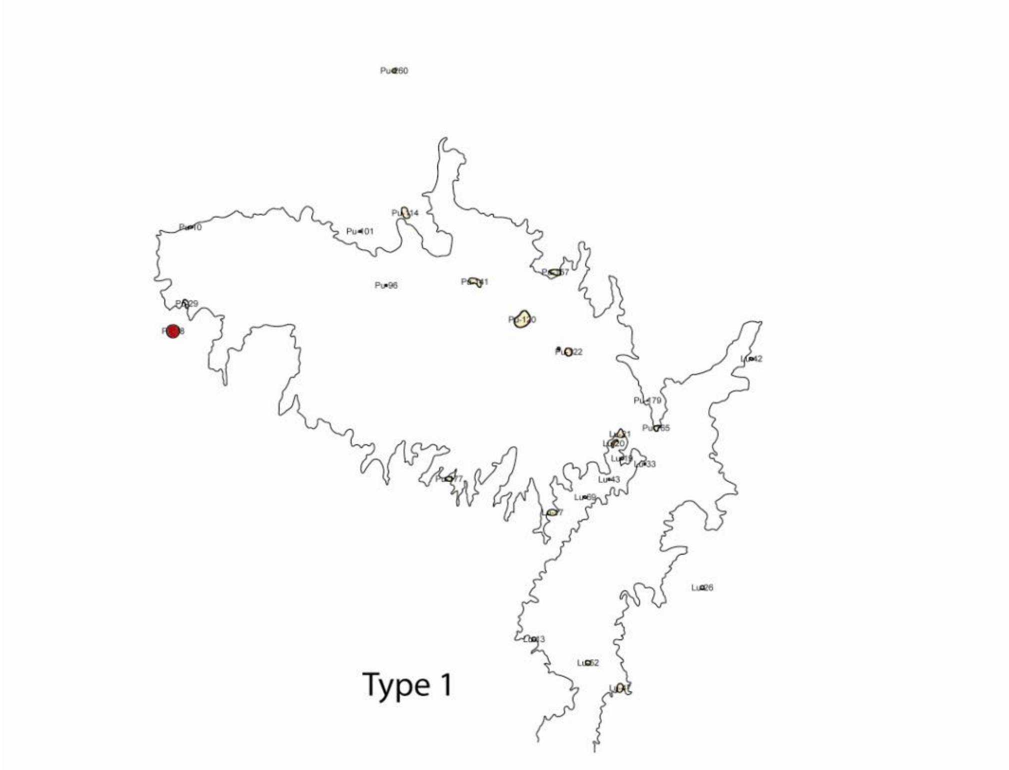

0 1 2 cm
Lu-43 surface
d=12 cm
Type 2
Lu-43 surface
d=10 cm
Type 9
Lu-43 surface
d=10 cm
Type 9
Lu-43 surface
d=18 cm
Type 9
Lu-43 surface
d=16 cm
Type 2
Lu-43 surface
d=18 cm
Type 9
Lu-43 surface
d=18 cm
Type 9

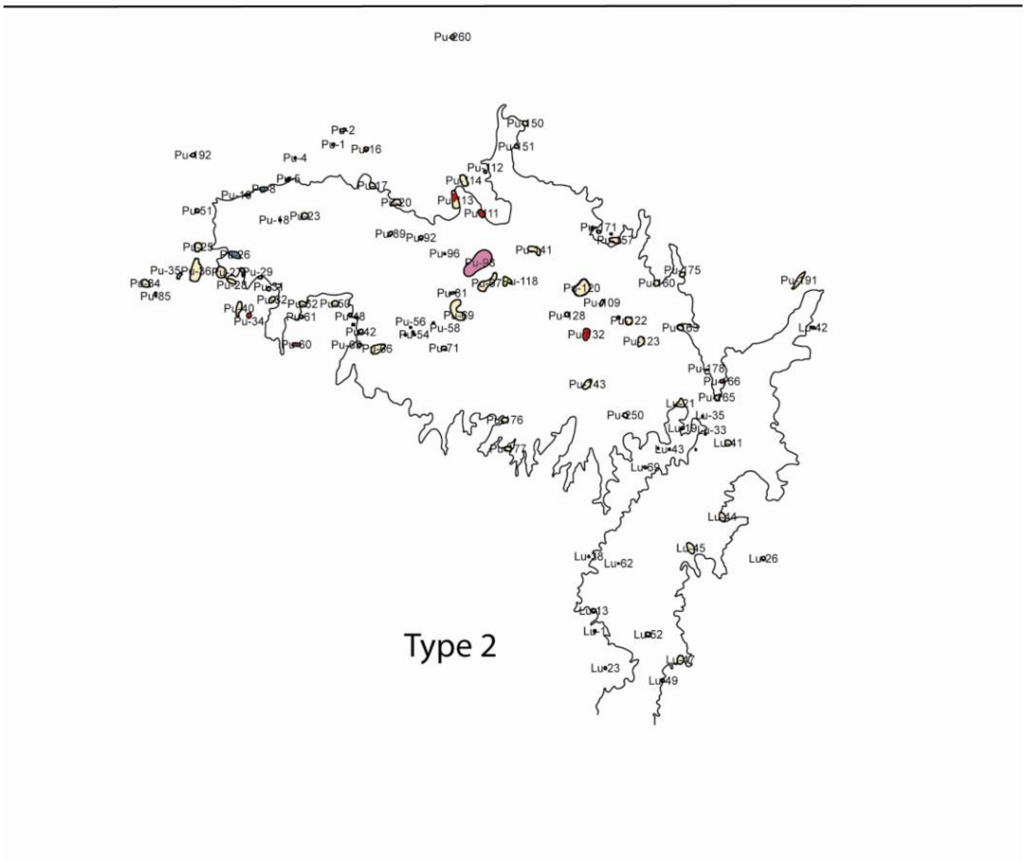

0 1 2 cm
Lu-52-39
Type 2
d=12 cm
Lu-54-2-1-10
Type 2
d=8 cm
Lu-54-A-1-52
Type 2
d=10 cm
0 2 4cm
Lu-69 Unit 1 Level 3:50-75 cm
d=28 cm

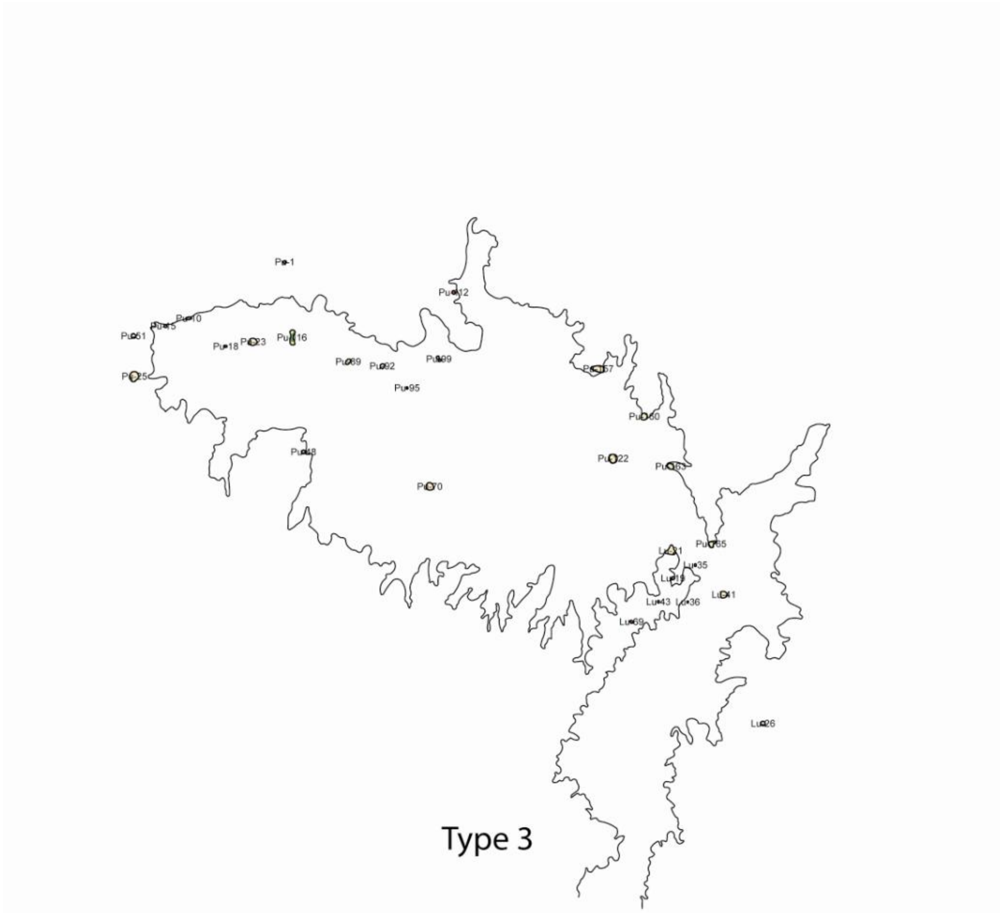
**Liucura Valley**

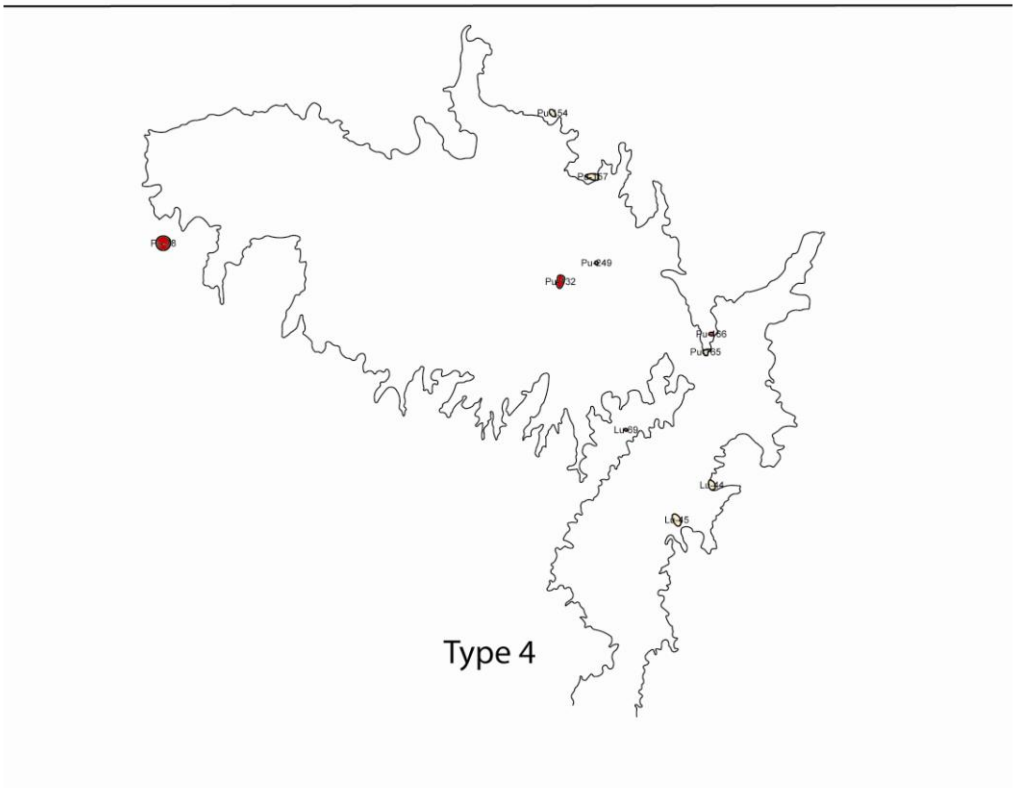


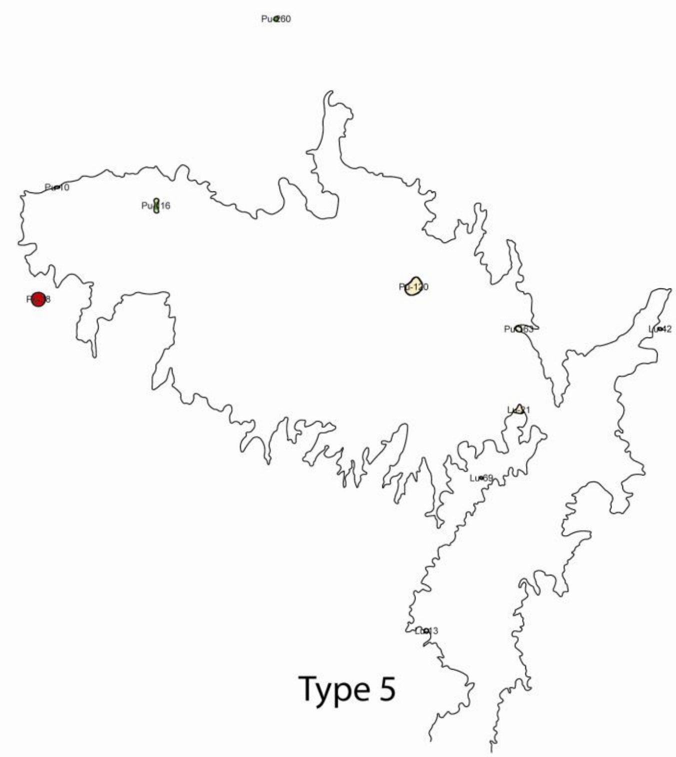
*Distribution Maps of Ceramic Types in the Purén and Lumaco Valley.*



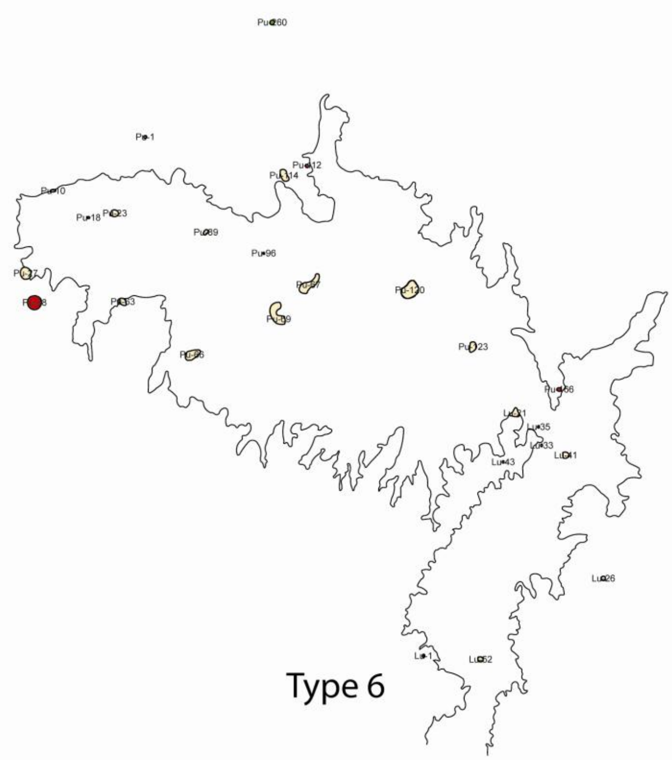




Type 3

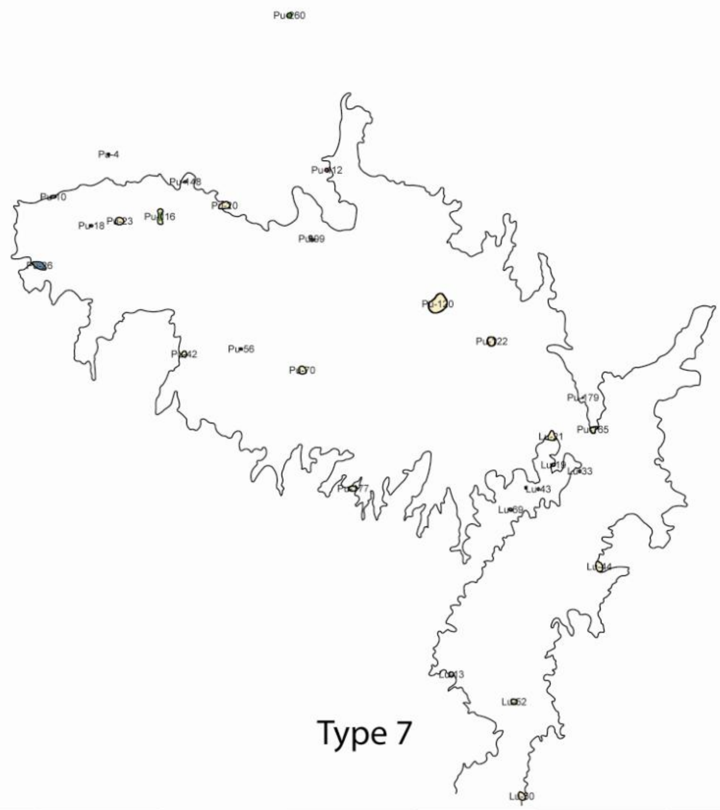

Type 4

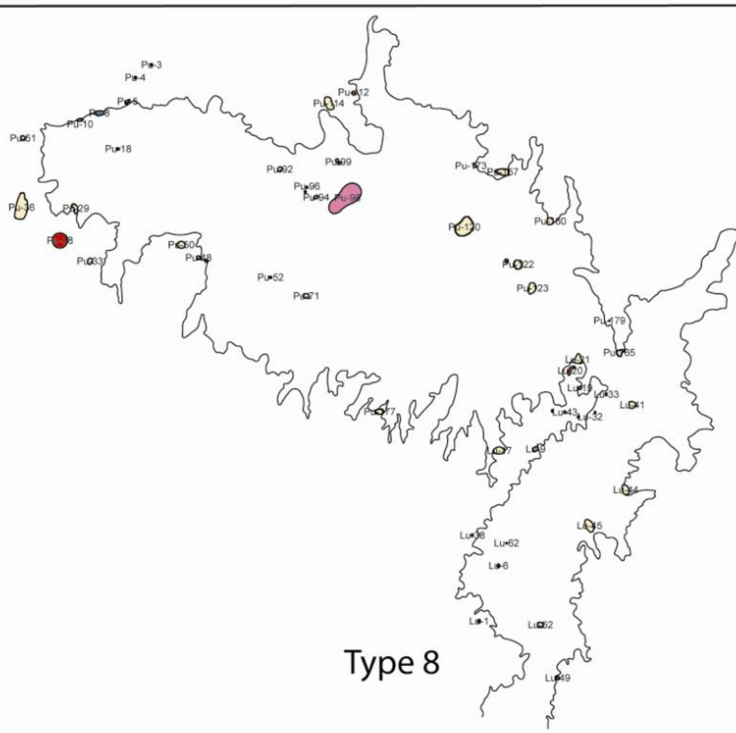


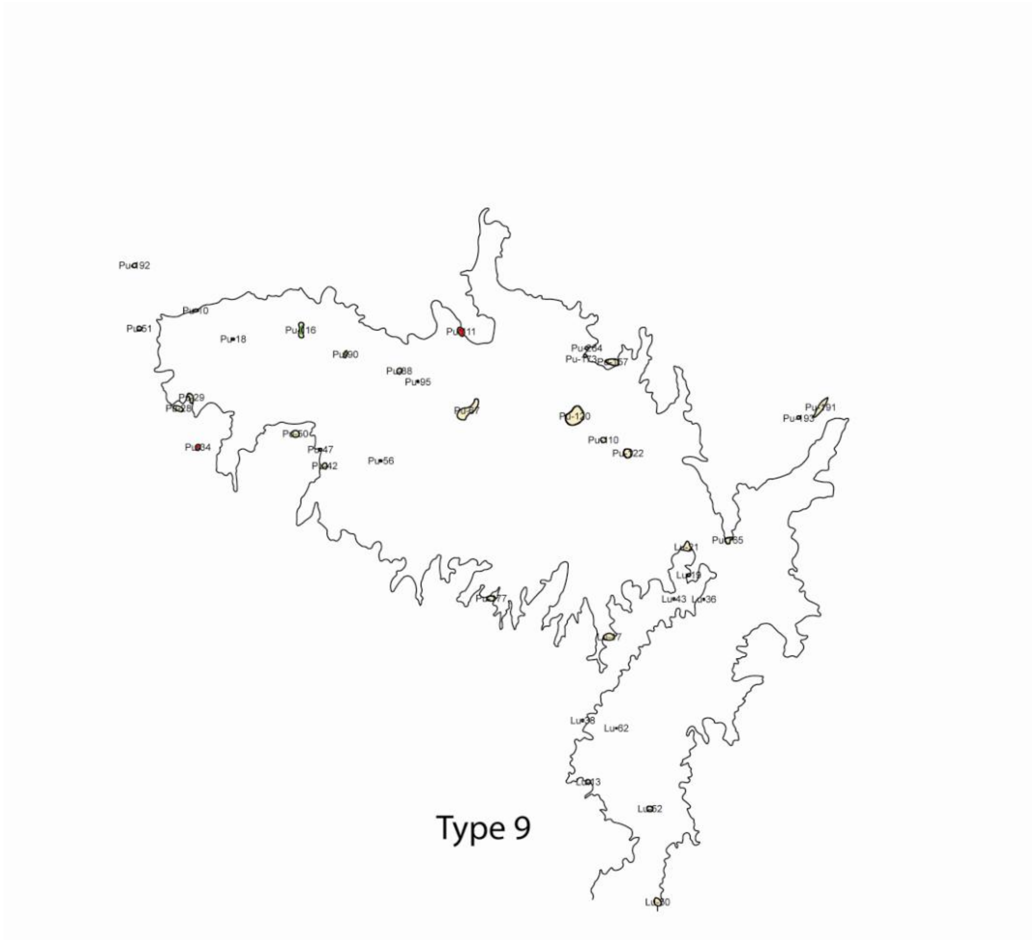
Type 5

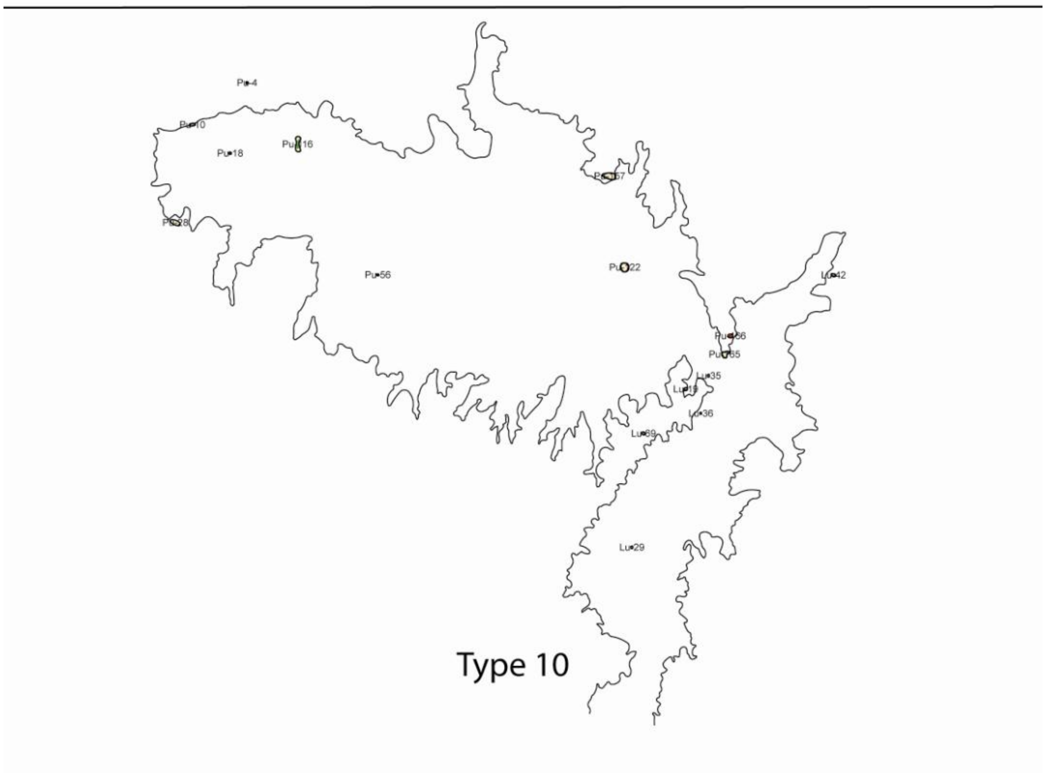


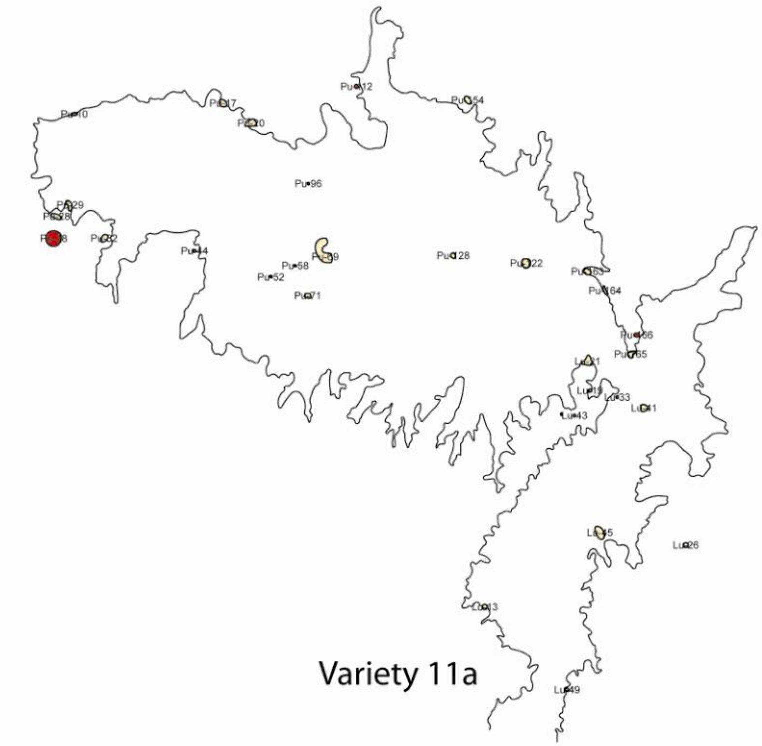

Type 6

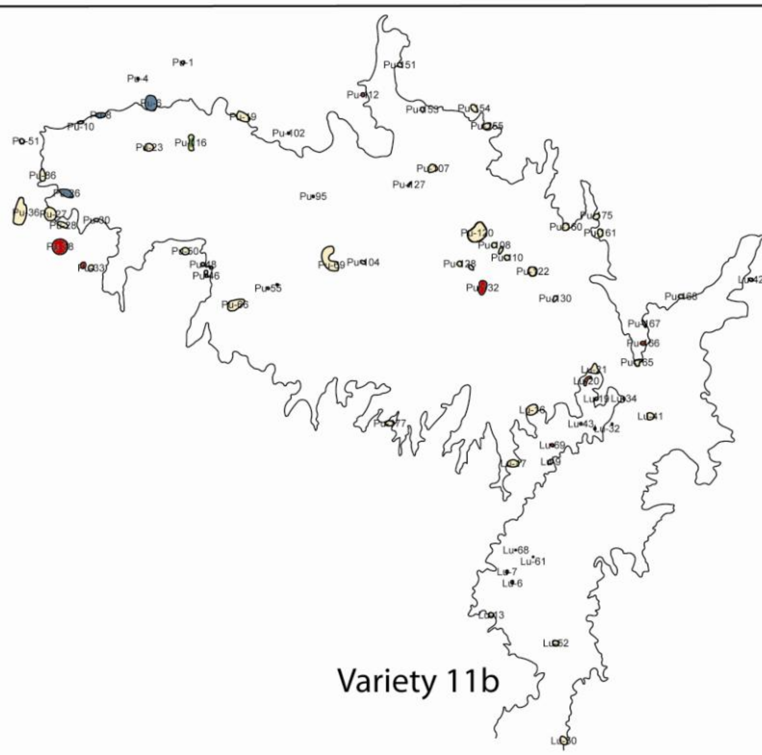

Type 7

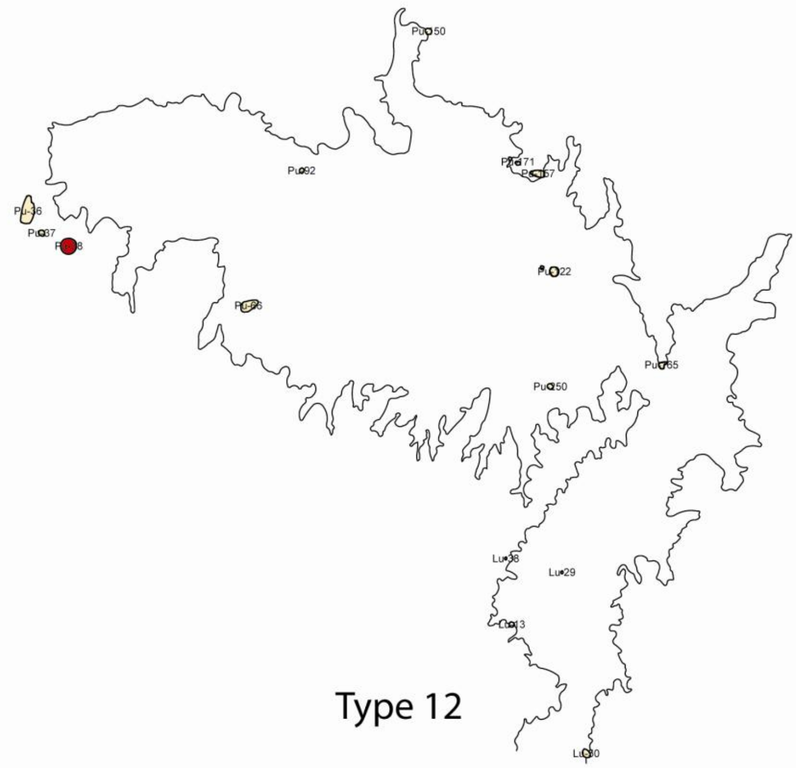

Type 8

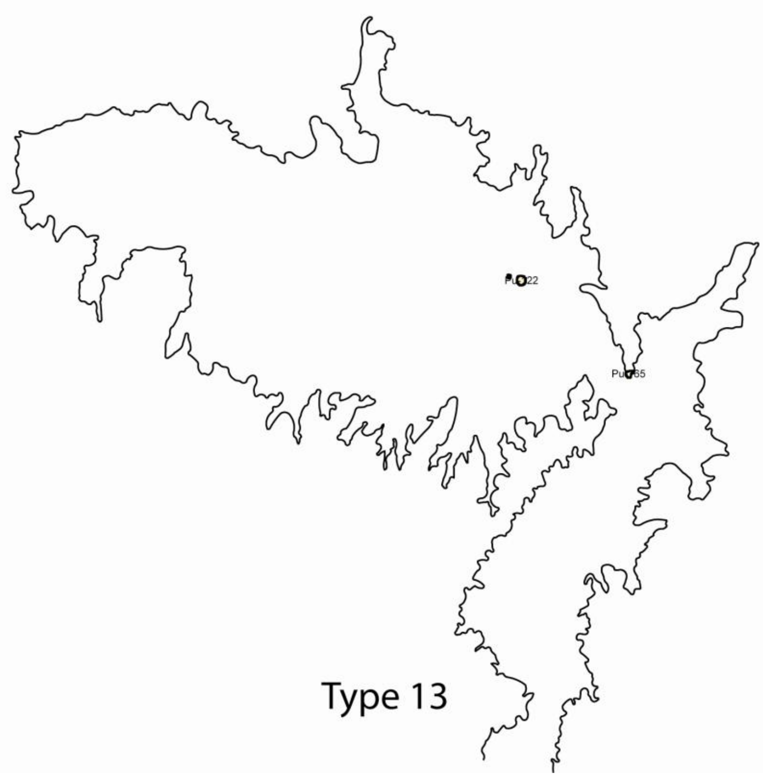

Type 9


Type 10


Variety 11a


Variety 11b


Type 12


Type 13

**Appendix III: Quantitative Distribution of Surface and Excavated Ceramic Types by Site Numbers. Site numbers of tested and excavated sites are in *italics*. Only those sites yielding cermics are listed below.**

| Site # | Type 1 | Variety 1A | Variety 1B | Type 2 | Type 3 | Type 4 | Type 5 | Type 6 | Type 7 | Type 8 | Type 9 | Type 10 | Type 11 | Variety 11A | Type 11B | Type 12 | Type 13 | Exotics | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lu-1 | | | | 1 | | | | 1 | | 2 | | | | | | | | | 4 |
| Lu-6 | | | | | | | | | | 1 | | | | | 1 | | | | 2 |
| Lu-7 | | | | | | | | | | | | | | | 2 | | | | 2 |
| Lu-8 | | | | | | | | | | | | | | | | | | 1 | 1 |
| Lu-9 | | | | | | | | | | 4 | | | | | 2 | | | | 6 |
| Lu-12 | | | | | | | | | | | | | | | | | | | 0 |
| Lu-13 | 1 | | | 7 | | | 1 | | 1 | | 2 | | | 1 | 25 | 8 | | | 46 |
| Lu-15 | | | | | | | | | | | | | | | | | | | 0 |
| Lu-16 | | | | | | | | | | | | | | | 1 | | | | 1 |
| Lu-17 | 1 | 8 | | | | | | | | 6 | 1 | | | | 11 | | | | 27 |
| *Lu-19* | 1 | | | 11 | 22 | | | | 1 | 4 | 2 | 5 | | 3 | 11 | | | | 60 |
| Lu-20 | 1 | | | | | | | | | 5 | | | | | 11 | | | 2 | 19 |
| *Lu-21* | 3 | | | 41 | 4 | | 2 | 3 | 3 | 7 | 7 | | 1 | 52 | 27 | | | | 150 |
| Lu-23 | | | | 1 | | | | | | | | | | | | | | | 1 |
| Lu-26 | 4 | | | 1 | 1 | | | 2 | | | | | | 4 | | | | | 12 |
| Lu-29 | | | | | | | | | | | | 1 | | | | 3 | | | 1 |
| *Lu-31* | | | | 6 | | | | | 27 | 8 | | | | 1 | | | | | 42 |
| Lu-32 | | | | | | | | | | 1 | | | | | 2 | | | 1 | 4 |
| Lu-33 | 1 | | | 6 | | | | 1 | 1 | 2 | | | | 2 | | | | | 13 |
| Lu-34 | | | | | | | | | | | | | | | 7 | | | | 7 |
| Lu-35 | | | | 8 | 1 | | | 2 | | | | 3 | | | | 1 | | 3 | 14 |
| *Lu-36* | | | | 22 | 3 | | | | | 6 | 1 | 1 | | | 5 | | | | 38 |
| Lu-38 | | | | 3 | | | | | | 2 | 5 | | | | | 3 | | | 13 |
| Lu-41 | | | | 4 | 1 | | | 1 | | 2 | | | | 1 | 1 | | | | 10 |
| Lu-42 | 3 | | | 17 | | | 1 | | | | | 1 | | | 1 | | | | 23 |
| *Lu-43* | 3 | | | 15 | 2 | | | 8 | 7 | 2 | 12 | | | 3 | 13 | | | | 65 |
| Lu-44 | | | | 1 | | 1 | | | 11 | 1 | | | | | | | | | 14 |
| Lu-45 | | | | 4 | | 3 | | | | 1 | | | | 1 | | | | 1 | 9 |
| Lu-47 | 1 | | | 4 | | | | | | | | | | | | | | | 5 |
| Lu-49 | | | | 4 | | | | | | 1 | | | | 4 | | | | | 9 |
| Lu-50 | | | | | | | | | 1 | | 1 | | | | 2 | 1 | | 1 | 6 |
| Lu-52 | 1 | | | 34 | | | | 3 | 9 | 1 | 10 | | | | 4 | | | | 62 |
| *Lu-54* | 16 | | | 117 | | | 6 | 6 | 1 | 23 | 17 | | | 4 | | | | | 190 |
| Lu-61 | | | | | | | | | | | | | | | 3 | | | | 3 |
| Lu-62 | | | | 2 | | | | | | 1 | 1 | | | | | | | | 4 |
| Lu-68 | | | | | | | | | | | | | | | 2 | | | | 2 |
| *LU-69* | 9 | | | 3 | 21 | 5 | 3 | | 2 | | | 1 | | | 41 | | | | 85 |
| Lu-91 | | | | 2 | | | | | | | | | | | 1 | | | | 3 |
| Lu-126 | | | | | | | | | | | | | | | 5 | | | | 5 |

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pu-1 | | | | **2** | **1** | | | **2** | | | | | | | **6** | | | | **11** |
| Pu-2 | | | | 3 | | | | | | | | | | | | | | 2 | **5** |
| Pu-3 | | | | | | | | | | 1 | | | | | | | | | **1** |
| Pu-4 | | | | **30** | | | | | **2** | **4** | | **6** | | | **3** | | | **1** | **46** |
| Pu-5 | | | | 4 | | | | | | 3 | | | | | | | | | **7** |
| Pu-6 | | | | | | | | | | | | | | | 1 | | | | **1** |
| Pu-8 | | | | 18 | | | | | | 8 | | | | | 1 | | | 1 | **28** |
| *Pu-10* | **3** | | | **15** | **9** | | **1** | **7** | **9** | **3** | **14** | **4** | | **9** | **4** | | | | **78** |
| Pu-14 | | | | | | | | | | | | | | | | | | | **0** |
| Pu-15 | | | | | **1** | | | | | | | | | | | | | | **1** |
| Pu-16 | | | | 13 | | | | | | | | | | | | | | | **13** |
| Pu-17 | 3 | | | 8 | | | | | | | | | | 1 | | | | | **12** |
| *Pu-18* | | | | 10 | 1 | | | 9 | 3 | 4 | 5 | 1 | | | | | | 1 | **34** |
| Pu-19 | | | | | | | | | | | | | | | 4 | | | | **4** |
| Pu-20 | | | | 10 | | | | | 2 | | | | | 1 | | | | 2 | **13** |
| Pu-23 | | | | 7 | 2 | | | 1 | 1 | | | | | | 2 | | | | **13** |
| Pu-25 | | | | 6 | 4 | | | | | | | | | | | | | | **10** |
| Pu-26 | | | | **1** | | | | | **2** | | | | | | **12** | | | | **15** |
| Pu-27 | | | | **7** | | | | **1** | | | | | | | **2** | | | | **10** |
| Pu-28 | | | | 2 | | | | | | | 2 | 1 | | 1 | 2 | | | 2 | **8** |
| Pu-29 | 1 | | | 1 | | | | | | 1 | 1 | | | 2 | | | | | **6** |
| Pu-30 | | | | 8 | | | | | | | | | | | 1 | | | 1 | **9** |
| Pu-31 | | | | 1 | | | | | | | | | | | | | | | **1** |
| Pu-32 | | | | 3 | | | | | | | | | | 1 | | | | | **4** |
| Pu-33 | | | | | | | | | | 1 | | | | | 3 | | | 1 | **5** |
| Pu-34 | | | | 1 | | | | | | | 2 | | | | 1 | | | | **4** |
| Pu-35 | | | | 2 | | | | | | | | | | | 4 | 1 | | | **6** |
| *PU-36* | **11** | | | **20** | **2** | | | | **2** | **4** | | | | | **83** | **3** | | | **122** |
| Pu-37 | | | | | | | | | | | | | | | | 1 | | | **0** |
| *Pu-38* | **1** | | | | | **1** | **1** | **1** | | **4** | | | | **5** | **6** | **1** | | | **19** |
| Pu-40 | | | | 12 | | | | | | | | | | | | | | | **12** |
| Pu-42 | | | | 10 | | | | | 1 | | 1 | | | | | | | 2 | **14** |
| Pu-44 | | | | | | | | | | | | | | 6 | | | | | **6** |
| Pu-45 | | | | 1 | | | | | | | | | | | 7 | | | | **8** |
| Pu-46 | | | | | | | | | | | | | | | 6 | | | | **6** |
| Pu-47 | | | | 23 | | | | | | 2 | 5 | | | | 5 | | | | **35** |
| Pu-48 | | | | 14 | 2 | | | | | 1 | | | | | 1 | | | | **18** |
| Pu-50 | | | | 1 | | | | | | 1 | 1 | | | | 1 | | | | **4** |
| Pu-51 | | | | **5** | **1** | | | | | **2** | **5** | | | | **7** | | | | **20** |
| Pu-52 | | | | 20 | | | | | | 7 | | | | 1 | 18 | | | | **46** |
| Pu-54 | | | | 3 | | | | | | | | | | | | | | | **3** |
| Pu-55 | | | | 29 | | | | | 2 | | | | | | 1 | | | | **32** |
| Pu-56 | | | | 4 | | | | | 1 | | 3 | 1 | | | | | | | **9** |
| Pu-58 | | | | **10** | | | | | | | | | | **2** | | | | | **12** |
| Pu-60 | | | | 2 | | | | | | | | | | | | | | | **2** |
| Pu-61 | | | | 1 | | | | | | | | | | | | | | | **1** |

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pu-62 | | | | 1 | | | | | | | | | | | | | | | **1** |
| Pu-63 | | | | | | | | **3** | | | | | | | | | | | **3** |
| Pu-65 | | | | **23** | | | | | | | | | | | | | | | **23** |
| Pu-66 | | | | 1 | | | | 3 | | | | | | | 5 | 1 | | | **9** |
| Pu-67 | | | | 5 | | | | 1 | | | 4 | | | | | | | 1 | **10** |
| Pu-69 | | | | 5 | | | | 1 | | | | | | 2 | 6 | | | | **14** |
| Pu-70 | | | | | 3 | | | | 1 | | | | | | | | | | **4** |
| Pu-71 | | | | 1 | | | | | | 1 | | | | 1 | | | | | **3** |
| Pu-81 | | | | 1 | | | | | | | | | | | | | | | **1** |
| Pu-83 | | | | | | | | | | | | | | | | | | | **0** |
| Pu-84 | | | | 3 | | | | | | | | | | | | | | | **3** |
| Pu-85 | | | | 3 | | | | | | | | | | | | | | | **3** |
| Pu-86 | | | | | | | | | | | | | | | 1 | | | | **1** |
| Pu-87 | | | | | | | | | | | | | | | | | | 1 | **1** |
| Pu-88 | | | | | | | | | | | 1 | | | | | | | | **1** |
| Pu-89 | | | | 4 | 1 | | | 1 | | | | | | | | | | | **6** |
| Pu-90 | | | | | | | | | | | 1 | | | | | | | | **1** |
| Pu-92 | | | | 8 | 3 | | | | | 1 | | | | | | 1 | | | **12** |
| Pu-94 | | | | | | | | | | **14** | | | | | | | | | **14** |
| Pu-95 | | | | | 1 | | | | | 1 | 3 | | | | 1 | | | | **6** |
| Pu-96 | 1 | | | 9 | | | | 2 | | 5 | | | | 3 | | | | | **20** |
| Pu-98 | | | | 5 | | | | | | 1 | | | | | | | | | **6** |
| Pu-99 | | | | | 1 | | | | 5 | 1 | | | | | | | | | **7** |
| Pu-101 | **20** | | | | | | | | | | | | | | | | | | **20** |
| Pu-102 | | | | | | | | | | | | | | | 1 | | | | **1** |
| Pu-104 | | | | | | | | | | | | | | | 1 | | | | **1** |
| Pu-105 | | | | | | | | | | | | | | | | | | | **0** |
| Pu-107 | | | | | | | | | | | | | | | 2 | | | | **2** |
| Pu-108 | | | | | | | | | | | | | | | 3 | | | | **3** |
| Pu-109 | | | | 3 | | | | | | | | | | | 1 | | | | **4** |
| Pu-110 | | | | | | | | | | | 3 | | | | 1 | | | | **4** |
| Pu-111 | | | | 1 | | | | | | | 2 | | | | | | | | **3** |
| Pu-112 | | | | **2** | **1** | | | **2** | | **1** | **1** | | | **1** | **1** | | | | **9** |
| Pu-113 | | | | 1 | | | | | | | | | | | | | | | **1** |
| Pu-114 | 1 | | | 12 | | | | 1 | | 1 | | | | | | | | | **15** |
| Pu-116 | | | | | 3 | | 3 | | 1 | | 3 | 1 | | | 5 | | | | **16** |
| Pu-118 | | | | **8** | | | | | | | | | | | | | | | **8** |
| *Pu-120* | **14** | | | **263** | | | **2** | **2** | **2** | **2** | **3** | | | **11** | **3** | **5** | | | **302** |
| *Pu-122* | **25** | | | **107** | **12** | **2** | **4** | **5** | **37** | **34** | **197** | **14** | | **156** | **36** | **5** | **1** | **3** | **629** |
| Pu-123 | | | | 1 | | | | 4 | | 2 | | | | | | | | | **7** |
| Pu-127 | | | | | | | | | | | | | | | 1 | | | | **1** |
| Pu-128 | | | | 7 | | | | | | | | | | 1 | 4 | | | 2 | **14** |
| Pu-129 | | | | | | | | | | | | | | | 3 | | | | **3** |
| Pu-130 | | | | | | | | | | | | | | | 1 | | | | **1** |
| *PU-132* | | | | **1** | | **4** | | | | | | | | | **4** | | | | **9** |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pu-141 | 2 | | | 2 | | | | | | | | | | | | | | | **4** |
| Pu-143 | | | | 1 | | | | | | | | | | | | | | | **1** |
| Pu-148 | | | | | | | | | 4 | | | | | | | | | | **4** |
| Pu-150 | | | | 1 | | | | | | | | | | | | 2 | | | **1** |
| Pu-151 | | | | 1 | | | | | | | | | | | 1 | | | | **2** |
| Pu-153 | | | | | | | | | | | | | | | 1 | | | 1 | **2** |
| Pu-154 | | | | | | 1 | | | | | | | | 1 | 5 | | | | **7** |
| Pu-155 | | | | | | | | | | | | | | | 1 | | | | **1** |
| Pu-157 | **11** | | | **75** | **3** | **4** | | **1** | | **2** | **1** | **3** | | **10** | **46** | **6** | | | **156** |
| Pu-160 | | | | **3** | **1** | | | | | **1** | | | | | **2** | | | | **7** |
| Pu-161 | | | | | | | | | | | | | | | 3 | | | | **3** |
| Pu-163 | | | | 1 | 2 | | 1 | | | | | | | 1 | | | | | **5** |
| Pu-164 | | | | | | | | | | | | | | 4 | | | | | **4** |
| *PU-165* | **1076** | **228** | **92** | **5338** | **181** | **145** | **28** | **353** | **179** | **172** | **112** | **102** | **742** | **1046** | **442** | **5** | **3** | **18** | **10236** |
| Pu-166 | | | | **44** | | **7** | | **1** | | | | | | **4** | **2** | | | | **58** |
| Pu-167 | | | | | | | | | | | | | | | 1 | | | | **1** |
| Pu-168 | | | | | | | | | | | | | | | 2 | | | | **2** |
| Pu-171 | | | | 1 | | | | | | | | | | | | 1 | | | **1** |
| Pu-173 | | | | | | | | | | 1 | 3 | | | | | | | | **4** |
| Pu-174 | | | | 1 | | | | | | | | | | | | | | | **1** |
| Pu-175 | | | | 3 | | | | | | | | | | | 2 | | | | **5** |
| Pu-176 | | | | 4 | | | | | | | | | | | | | | | **4** |
| Pu-177 | 6 | | | 15 | | | | | 2 | 4 | 6 | | | | 4 | | | 1 | **38** |
| Pu-178 | | | | 1 | | | | | | | | | | | | | | | |
| Pu-179 | 1 | | | 6 | | | | | 1 | 1 | | | | | | | | | **9** |
| Pu-191 | | | | 1 | | | | | | | 1 | | | | | | | | **2** |
| Pu-192 | | | | 1 | | | | | | | 1 | | | | | | | | **2** |
| Pu-193 | | | | | | | | | | | 1 | | | | | | | | **1** |
| Pu-249 | **1** | | | **9** | | **1** | | | | **20** | | | **4** | | | **1** | | | **36** |
| Pu-250 | | | | 3 | | | | | | | | | | | | 1 | | | **4** |
| Pu-260 | 1 | | | 11 | | | 1 | 3 | 5 | | | | 17 | | | | | 1 | **39** |
| Pu-264 | | | | 1 | | | | | | | | | | | | 6 | | | **7** |
| Pu-277 | | | | | | | | | | | 2 | | | | | | | | **2** |
| Pu-298 | | | | | | | | **2** | | **2** | **6** | | | | | **3** | | | **13** |
| **Totals** | **1221** | **236** | **92** | **6636** | **297** | **174** | **54** | **433** | **331** | **404** | **454** | **146** | **764** | **1348** | **946** | **63** | **4** | **49** | **13652** |

**Appendix IV: Table 1: Chemical Group Assignments for Pottery and Clays from the Purén-Lumaco Region.**

| MURR ID | Chemical Group | Site | Material | Ceramic Ware | Ceramic Type |
|---|---|---|---|---|---|
| TDD171 | Group 1 | PU21.2.2.1 | Ceramic | 6 | 6 |
| TDD173 | Group 1 | PU 165 | Ceramic | 6 | 6 |
| TDD174 | Group 1 | PU 165 | Ceramic | 6 | 6 |
| TDD175 | Group 1 | PU 165 | Ceramic | 3 | 3 |
| TDD302 | Group 1 | PU 132b | Ceramic | 9 | 9 |
| TDD335 | Group 1 | PU-165 | Ceramic | 5 | 5 |
| TDD004 | Group 2 | PU21.5.5 | Ceramic | 7 | 7 |
| TDD010 | Group 2 | PU 165 | Ceramic | 2 | 2 |
| TDD013 | Group 2 | PU 165 | Ceramic | 1 | 1 |
| TDD018 | Group 2 | PU 165 | Ceramic | 2 | 2 |
| TDD019 | Group 2 | PU 165 | Ceramic | 7 | 7 |
| TDD023 | Group 2 | PU 165 | Ceramic | 8 | 8 |
| TDD025 | Group 2 | PU 165 | Ceramic | 2 | 2 |
| TDD033 | Group 2 | PU 165 | Ceramic | 1 | 1 |
| TDD038 | Group 2 | PU 165 | Ceramic | 2 | 2 |
| TDD044 | Group 2 | PU 165 | Ceramic | 2 | 2 |
| TDD045 | Group 2 | PU 165 | Ceramic | 2 | 2 |
| TDD050 | Group 2 | PU 165 | Ceramic | 6 | 6 |
| TDD056 | Group 2 | PU 165 | Ceramic | 11 | 11 |
| TDD057 | Group 2 | PU 165 | Ceramic | 11 | 11 |
| TDD060 | Group 2 | LU69 10-3 | Ceramic | 11 | 11 |
| TDD061 | Group 2 | PU 165 | Ceramic | 6 | 6 |

| | | | | | |
|---|---|---|---|---|---|
| TDD062 | Group 2 | PU 165 | Ceramic | 6 | 6 |
| TDD063 | Group 2 | PU 165 | Ceramic | 3 | 3 |
| TDD070 | Group 2 | PU 165 | Ceramic | 11 | 11 |
| TDD084 | Group 2 | PU 165 | Ceramic | 2 | 2 |
| TDD095 | Group 2 | PU 165 | Ceramic | 11 | 11 |
| TDD100 | Group 2 | PU 165 | Ceramic | | |
| TDD104 | Group 2 | PU 165 | Ceramic | 2 | 2 |
| TDD109 | Group 2 | PU 165 | Ceramic | 2 | 2 |
| TDD114 | Group 2 | PU165 | Ceramic | 6 | 6 |
| TDD119 | Group 2 | PU 165 | Ceramic | 8 | 8 |
| TDD125 | Group 2 | PU 165 | Ceramic | 6 | 6 |
| TDD129 | Group 2 | PU 165 | Ceramic | 4 | 4 |
| TDD130 | Group 2 | PU 165 | Ceramic | 1 | 1 |
| TDD145 | Group 2 | LU42.5.21 | Ceramic | 7 | 7 |
| TDD147 | Group 2 | PU 165 | Ceramic | | |
| TDD148 | Group 2 | PU101/PU49.5.5 | Ceramic | 2 | 2 |
| TDD167 | Group 2 | PU51.S.1 | Ceramic | 7 | 7 |
| TDD177 | Group 2 | PU 165 | Ceramic | 7 | 7 |
| TDD183 | Group 2 | PU 165 | Ceramic | 7 | 7 |
| TDD260 | Group 2 | PU 36 | Ceramic | 2 | 2 |
| TDD267 | Group 2 | PU 120 | Ceramic | 2 | 2 |
| TDD268 | Group 2 | PU 120 | Ceramic | 10 | 10 |
| TDD269 | Group 2 | PU 120 | Ceramic | 10 | 10 |
| TDD270 | Group 2 | PU 120 | Ceramic | 10 | 10 |

| | | | | | |
|---|---|---|---|---|---|
| TDD271 | Group 2 | PU 122 | Ceramic | 2 | 2 |
| TDD272 | Group 2 | PU 122 | Ceramic | 2 | 2 |
| TDD273 | Group 2 | PU 122 | Ceramic | 2 | 2 |
| TDD274 | Group 2 | PU 122 | Ceramic | 8 | 8 |
| TDD275 | Group 2 | PU 122 | Ceramic | 1 | 1 |
| TDD276 | Group 2 | PU 122 | Ceramic | 1 | 1 |
| TDD278 | Group 2 | PU 122 | Ceramic | 2 | 2 |
| TDD282 | Group 2 | PU 122 | Ceramic | 2 | 2 |
| TDD286 | Group 2 | PU 122 | Ceramic | 11 | 11 |
| TDD290 | Group 2 | PU 122 | Ceramic | 2 | 2 |
| TDD291 | Group 2 | PU 122 | Ceramic | 2 | 2 |
| TDD292 | Group 2 | PU 122 | Ceramic | 2 | 2 |
| TDD296 | Group 2 | PU 122 | Ceramic | 6 | 6 |
| TDD297 | Group 2 | PU 123 | Ceramic | 2 | 2 |
| TDD298 | Group 2 | PU 123 | Ceramic | 2 | 2 |
| TDD299 | Group 2 | PU 123 | Ceramic | 3 | 3 |
| TDD304 | Group 2 | PU 157 | Ceramic | 2 | 2 |
| TDD305 | Group 2 | PU 157 | Ceramic | 2 | 2 |
| TDD306 | Group 2 | PU 157 | Ceramic | 2 | 2 |
| TDD307 | Group 2 | PU 157 | Ceramic | 2 | 2 |
| TDD308 | Group 2 | PU 157 | Ceramic | 2 | 2 |
| TDD309 | Group 2 | PU 157 | Ceramic | 2 | 2 |
| TDD311 | Group 2 | PU 157 | Ceramic | 2 | 2 |
| TDD322 | Group 2 | PU 264 | Ceramic | 10 | 10 |

| | | | | | |
|---|---|---|---|---|---|
| TDD342 | Group 2 | Pu-165 | Ceramic | | 14 |
| TDD345 | Group 2 | Pu-42 | Ceramic | | 14 |
| TDD355 | Group 2 | Pu-165 | Ceramic | | |
| TDD357 | Group 2 | Pu-165 | Ceramic | | 4 |
| TDD001 | Group 3 | PU 165 | Ceramic | 1 | 1 |
| TDD002 | Group 3 | PU 165 | Ceramic | 8 | 8 |
| TDD003 | Group 3 | PU 165 | Ceramic | 2 | 2 |
| TDD005 | Group 3 | PU 165 | Ceramic | 2 | 2 |
| TDD006 | Group 3 | PU 165 | Ceramic | 2 | 2 |
| TDD008 | Group 3 | PU 165 | Ceramic | 2 | 2 |
| TDD011 | Group 3 | PU 165 | Ceramic | 1 | 1 |
| TDD012 | Group 3 | PU 165 | Ceramic | 2 | 2 |
| TDD014 | Group 3 | PU 165 | Ceramic | 4 | 4 |
| TDD016 | Group 3 | PU 165 | Ceramic | 2 | 2 |
| TDD020 | Group 3 | PU 165 | Ceramic | 6 | 6 |
| TDD021 | Group 3 | PU 165 | Ceramic | 8 | 8 |
| TDD022 | Group 3 | PU 165 | Ceramic | 6 | 6 |
| TDD026 | Group 3 | PU 165 | Ceramic | 9 | 9 |
| TDD027 | Group 3 | PU 165 | Ceramic | 1 | 1 |
| TDD028 | Group 3 | PU 165 | Ceramic | 2 | 2 |
| TDD029 | Group 3 | PU 165 | Ceramic | 2 | 2 |
| TDD031 | Group 3 | PU 165 | Ceramic | 2 | 2 |
| TDD035 | Group 3 | PU 165 | Ceramic | 2 | 2 |
| TDD036 | Group 3 | PU 165 | Ceramic | 2 | 2 |

| | | | | | |
|---|---|---|---|---|---|
| TDD037 | Group 3 | PU 165 | Ceramic | 1 | 1 |
| TDD039 | Group 3 | PU 165 | Ceramic | 2 | 2 |
| TDD040 | Group 3 | PU 165 | Ceramic | 2 | 2 |
| TDD041 | Group 3 | LU 69 | Ceramic | 2 | 2 |
| TDD042 | Group 3 | PU 165 | Ceramic | 1 | 1 |
| TDD043 | Group 3 | PU 165 | Ceramic | 2 | 2 |
| TDD046 | Group 3 | PU 165 | Ceramic | 1 | 1 |
| TDD047 | Group 3 | PU 165 | Ceramic | 9 | 9 |
| TDD048 | Group 3 | PU21.8.19 | Ceramic | 2 | 2 |
| TDD049 | Group 3 | PU 165 | Ceramic | 2 | 2 |
| TDD051 | Group 3 | PU 165 | Ceramic | 3 | 3 |
| TDD054 | Group 3 | PU 165 | Ceramic | 10 | 10 |
| TDD055 | Group 3 | PU 165 | Ceramic | 3 | 3 |
| TDD058 | Group 3 | PU 165 | Ceramic | clay daubs - | clay daubs - |
| TDD059 | Group 3 | PU 165 | Ceramic | 11 | 11 |
| TDD066 | Group 3 | PU 165 | Ceramic | 6 | 6 |
| TDD067 | Group 3 | PU 165 | Ceramic | 2 | 2 |
| TDD068 | Group 3 | PU 165 | Ceramic | 2 | 2 |
| TDD071 | Group 3 | PU 165 | Ceramic | 2 | 2 |
| TDD072 | Group 3 | PU 165 | Ceramic | 2 | 2 |
| TDD074 | Group 3 | PU 165 | Ceramic | 11 | 11 |
| TDD075 | Group 3 | PU 165 | Ceramic | 11 | 11 |
| TDD076 | Group 3 | PU 165 | Ceramic | 11 | 11 |
| TDD077 | Group 3 | LU 69 3-4 | Ceramic | 2 | 2 |

| | | | | | |
|---|---|---|---|---|---|
| TDD078 | Group 3 | PU 165 | Ceramic | 11 | 11 |
| TDD079 | Group 3 | PU 165 | Ceramic | 2 | 2 |
| TDD080 | Group 3 | PU 165 | Ceramic | 2 | 2 |
| TDD082 | Group 3 | PU 165 | Ceramic | 11 | 11 |
| TDD085 | Group 3 | PU 165 | Ceramic | 2 | 2 |
| TDD086 | Group 3 | PU 165 | Ceramic | 11 | 11 |
| TDD088 | Group 3 | LU 69 10-11 | Ceramic | 2 | 2 |
| TDD089 | Group 3 | PU 165 | Ceramic | 3 | 3 |
| TDD090 | Group 3 | PU 165 | Ceramic | 1 | 1 |
| TDD091 | Group 3 | PU 165 | Ceramic | 2 | 2 |
| TDD096 | Group 3 | PU 165 | Ceramic | 11 | 11 |
| TDD097 | Group 3 | PU 165 | Ceramic | 2 | 2 |
| TDD098 | Group 3 | PU 165 | Ceramic | 1 | 1 |
| TDD099 | Group 3 | PU 165 | Ceramic | 11 | 11 |
| TDD101 | Group 3 | PU 165 | Ceramic | 2 | 2 |
| TDD103 | Group 3 | PU 165 | Ceramic | 11 | 11 |
| TDD110 | Group 3 | PU 165 | Ceramic | 11 | 11 |
| TDD111 | Group 3 | PU 165 | Ceramic | 2 | 2 |
| TDD112 | Group 3 | PU 165 | Ceramic | 9 | 9 |
| TDD113 | Group 3 | PU165 | Ceramic | 6 | 6 |
| TDD115 | Group 3 | LU69 10-8 | Ceramic | 6 | 6 |
| TDD116 | Group 3 | PU 165 | Ceramic | 1 | 1 |
| TDD117 | Group 3 | LU69 3-3 | Ceramic | 1 | 1 |
| TDD118 | Group 3 | PU 165 | Ceramic | 2 | 2 |

| | | | | | |
|---|---|---|---|---|---|
| TDD120 | Group 3 | PU 165 | Ceramic | 1 | 1 |
| TDD123 | Group 3 | PU 165 | Ceramic | 2 | 2 |
| TDD124 | Group 3 | PU 165 | Ceramic | 10 | 10 |
| TDD126 | Group 3 | PU 165 | Ceramic | 6 | 6 |
| TDD127 | Group 3 | PU 165 | Ceramic | 3 | 3 |
| TDD131 | Group 3 | PU 165 | Ceramic | 2 | 2 |
| TDD132 | Group 3 | PU 165 | Ceramic | 1 | 1 |
| TDD134 | Group 3 | PU118.5.111 | Ceramic | 9 | 9 |
| TDD136 | Group 3 | PU65.3.16 | Ceramic | 3 | 3 |
| TDD137 | Group 3 | PU65.3.3 | Ceramic | 2 | 2 |
| TDD138 | Group 3 | PU118.5.3 | Ceramic | 2 | 2 |
| TDD139 | Group 3 | LU41-S | Ceramic | 2 | 2 |
| TDD141 | Group 3 | LU42.5.17 | Ceramic | 1 | 1 |
| TDD142 | Group 3 | PU4.5.18 | Ceramic | 2 | 2 |
| TDD144 | Group 3 | PU52.5.46 | Ceramic | 3 | 3 |
| TDD149 | Group 3 | PU 165 | Ceramic | 1 | 1 |
| TDD153 | Group 3 | PU 165 | Ceramic | 2 | 2 |
| TDD154 | Group 3 | PU49.5.7 | Ceramic | 2 | 2 |
| TDD155 | Group 3 | PU 165 | Ceramic | 2 | 2 |
| TDD156 | Group 3 | PU52.S.31 | Ceramic | 3 | 3 |
| TDD157 | Group 3 | PU 165 | Ceramic | 2 | 2 |
| TDD158 | Group 3 | PU52.5.116 | Ceramic | 2 | 2 |
| TDD159 | Group 3 | PU 165 | Ceramic | 1 | 1 |
| TDD164 | Group 3 | LU69 | Ceramic | 3 | 3 |

| | | | | | |
|---|---|---|---|---|---|
| TDD166 | Group 3 | PU165 | Ceramic | 2 | 2 |
| TDD185 | Group 3 | PU 165 | Ceramic | 6 | 6 |
| TDD233 | Group 3 | Purén-Lumaco | Clay | n/a | n/a |
| TDD238 | Group 3 | Purén-Lumaco | Clay | n/a | n/a |
| TDD242 | Group 3 | Purén-Lumaco | Clay | n/a | n/a |
| TDD262 | Group 3 | PU 36 | Ceramic | 2 | 2 |
| TDD263 | Group 3 | PU 36 | Ceramic | 2 | 2 |
| TDD264 | Group 3 | PU 36 | Ceramic | 2 | 2 |
| TDD265 | Group 3 | PU 36 | Ceramic | 2 | 2 |
| TDD279 | Group 3 | PU 122 | Ceramic | 2 | 2 |
| TDD287 | Group 3 | PU 122 | Ceramic | 2 | 2 |
| TDD289 | Group 3 | PU 122 | Ceramic | 2 | 2 |
| TDD293 | Group 3 | PU 122 | Ceramic | 2 | 2 |
| TDD300 | Group 3 | PU 123 | Ceramic | 6 | 6 |
| TDD301 | Group 3 | PU 123 | Ceramic | 8 | 8 |
| TDD303 | Group 3 | PU 136 | Ceramic | 2 | 2 |
| TDD310 | Group 3 | PU 157 | Ceramic | 1 | 1 |
| TDD312 | Group 3 | PU 157 | Ceramic | 2 | 2 |
| TDD314 | Group 3 | PU 157 | Ceramic | 11 | 11 |
| TDD315 | Group 3 | PU 249 | Ceramic | 2 | 2 |
| TDD317 | Group 3 | PU 249 | Ceramic | 6 | 6 |
| TDD318 | Group 3 | PU 249 | Ceramic | 6 | 6 |
| TDD319 | Group 3 | PU 249 | Ceramic | 8 | 8 |
| TDD320 | Group 3 | PU 249 | Ceramic | 8 | 8 |

| | | | | | |
|---|---|---|---|---|---|
| TDD321 | Group 3 | PU 264 | Ceramic | 2 | 2 |
| TDD326 | Group 3 | | Clay | | |
| TDD333 | Group 3 | Pu-165 | Ceramic | | 4 |
| TDD337 | Group 3 | PU-165 | Ceramic | | |
| TDD338 | Group 3 | PU-165 | Ceramic | | |
| TDD340 | Group 3 | Pu-165 | Ceramic | | |
| TDD341 | Group 3 | Pu-165 | Ceramic | | |
| TDD346 | Group 3 | Pu-165 | Ceramic | | 14 |
| TDD347 | Group 3 | Pu-165 | Ceramic | | |
| TDD349 | Group 3 | Pu-5 | Ceramic | | 14 |
| TDD350 | Group 3 | Pu-5 | Ceramic | | 14 |
| TDD352 | Group 3 | Pu-165 | Ceramic | | |
| TDD356 | Group 3 | Pu-165 | Ceramic | | |
| TDD358 | Group 3 | Pu-165 | Ceramic | | 4 |
| TDD007 | Unassigned | PU 165 | Ceramic | 2 | 2 |
| TDD009 | Unassigned | PU 165 | Ceramic | 9 | 9 |
| TDD015 | Unassigned | PU 165 | Ceramic | 2 | 2 |
| TDD017 | Unassigned | PU 165 | Ceramic | 10 | 10 |
| TDD024 | Unassigned | PU 165 | Ceramic | 2 | 2 |
| TDD030 | Unassigned | PU 165 | Ceramic | 3 | 3 |
| TDD032 | Unassigned | PU 165 | Ceramic | 2 | 2 |
| TDD034 | Unassigned | PU 165 | Ceramic | 8 | 8 |
| TDD052 | Unassigned | PU 165 | Ceramic | 1 | 1 |
| TDD053 | Unassigned | PU 165 | Ceramic | | |

| | | | | | |
|---|---|---|---|---|---|
| TDD064 | Unassigned | PU 165 | Ceramic | 3 | 3 |
| TDD065 | Unassigned | PU 165 | Ceramic | 6 | 6 |
| TDD069 | Unassigned | PU 165 | Ceramic | 2 | 2 |
| TDD073 | Unassigned | PU 165 | Ceramic | 2 | 2 |
| TDD081 | Unassigned | PU 165 | Ceramic | 9 | 9 |
| TDD083 | Unassigned | PU 165 | Ceramic | 2 | 2 |
| TDD087 | Unassigned | PU 165 | Ceramic | 11 | 11 |
| TDD092 | Unassigned | PU 165 | Ceramic | 1 | 1 |
| TDD093 | Unassigned | PU 165 | Ceramic | 11 | 11 |
| TDD094 | Unassigned | PU 165 | Ceramic | 11 | 11 |
| TDD102 | Unassigned | LU69 2-3 | Ceramic | 3 | 3 |
| TDD105 | Unassigned | PU 165 | Ceramic | 11 | 11 |
| TDD106 | Unassigned | PU 165 | Ceramic | 11 | 11 |
| TDD108 | Unassigned | PU 165 | Ceramic | 11 | 11 |
| TDD121 | Unassigned | PU 165 | Ceramic | 6 | 6 |
| TDD122 | Unassigned | PU 165 | Ceramic | 2 | 2 |
| TDD128 | Unassigned | PU 165 | Ceramic | 1 | 1 |
| TDD133 | Unassigned | PU 165 | Ceramic | 9 | 9 |
| TDD135 | Unassigned | PU118.5.8 | Ceramic | 2 | 2 |
| TDD140 | Unassigned | LU4.5.22 | Ceramic | 2 | 2 |
| TDD143 | Unassigned | LU4.5.56 | Ceramic | 7 | 7 |
| TDD146 | Unassigned | PU40.5.2 | Ceramic | 1 | 1 |
| TDD150 | Unassigned | PU 165 | Ceramic | 1 | 1 |
| TDD151 | Unassigned | PU 165 | Ceramic | 2 | 2 |

| | | | | | |
|---|---|---|---|---|---|
| TDD152 | Unassigned | PU 165 | Ceramic | 2 | 2 |
| TDD160 | Unassigned | PU 165 | Ceramic | 3 | 3 |
| TDD161 | Unassigned | PU61.3.15 | Ceramic | 2 | 2 |
| TDD162 | Unassigned | PU 165 | Ceramic | 1 | 1 |
| TDD163 | Unassigned | PU51.3.5 | Ceramic | 2 | 2 |
| TDD165 | Unassigned | PU 165 | Ceramic | 2 | 2 |
| TDD168 | Unassigned | PU51.S.2 | Ceramic | 5 | 5 |
| TDD169 | Unassigned | PU51.S.3 | Ceramic | 7 | 7 |
| TDD170 | Unassigned | PU51.S.4 | Ceramic | 5 | 5 |
| TDD172 | Unassigned | PU21.2.2.2 | Ceramic | 6 | 6 |
| TDD176 | Unassigned | PU 165 | Ceramic | 1 | 1 |
| TDD178 | Unassigned | PU 165 | Ceramic | 5 | 5 |
| TDD179 | Unassigned | PU21 SE-1 | Ceramic | 3 | 3 |
| TDD180 | Unassigned | PU21 SE-2 | Ceramic | 1 | 1 |
| TDD181 | Unassigned | PU21 SE-3 | Ceramic | 7 | 7 |
| TDD182 | Unassigned | PU21 SE-4 | Ceramic | 6 | 6 |
| TDD184 | Unassigned | PU 165 | Ceramic | 1 | 1 |
| TDD186 | Unassigned | PU 165 | Ceramic | 6 | 6 |
| TDD187 | Unassigned | PU 165 | Ceramic | 1 | 1 |
| TDD188 | Unassigned | PU 165 | Ceramic | 1 | 1 |
| TDD189 | Unassigned | PU 165 | Ceramic | 1 | 1 |
| TDD190 | Unassigned | PU 165 | Ceramic | 5 | 5 |
| TDD259 | Unassigned | Purén-Lumaco | Clay | n/a | n/a |
| TDD261 | Unassigned | PU 36 | Ceramic | 2 | 2 |

| | | | | | |
|---|---|---|---|---|---|
| TDD266 | Unassigned | PU 38 | Burnt clay | Burnt Clay | Burnt Clay |
| TDD277 | Unassigned | PU 122 | Ceramic | 2 | 2 |
| TDD280 | Unassigned | PU 122 | Ceramic | 2 | 2 |
| TDD281 | Unassigned | PU 122 | Ceramic | 6 | 6 |
| TDD283 | Unassigned | PU 122 | Ceramic | 2 | 2 |
| TDD284 | Unassigned | PU 122 | Ceramic | 2 | 2 |
| TDD285 | Unassigned | PU 122 | Ceramic | 6 | 6 |
| TDD288 | Unassigned | PU 122 | Ceramic | 6 | 6 |
| TDD294 | Unassigned | PU 122 | Ceramic | 2 | 2 |
| TDD295 | Unassigned | PU 122 | Ceramic | 6 | 6 |
| TDD313 | Unassigned | PU 157 | Ceramic | 1 | 1 |
| TDD316 | Unassigned | PU 249 | Ceramic | 6 | 6 |
| TDD323 | Unassigned | PU 264 | Ceramic | 12 | 12 |
| TDD334 | Unassigned | Pu-122 | Ceramics | | 14 |
| TDD336 | Unassigned | PU-165 | Ceramics | | 14 |
| TDD339 | Unassigned | Pu-165 | Ceramics | | |
| TDD343 | Unassigned | Pu-122 | Ceramics | | 14 |
| TDD344 | Unassigned | Pu-122 | Ceramics | | 14 |
| TDD348 | Unassigned | Pu-165 | Ceramics | | |
| TDD351 | Unassigned | Pu-165 | Ceramics | | 14 |
| TDD353 | Unassigned | Pu-165 | Ceramics | | |
| TDD354 | Unassigned | Lu-45 | Ceramics | | 14 |
| TDD359 | Unassigned | Pu-165 | Ceramics | | |
| TDD360 | Unassigned | Maicoya | Ceramics | | |

| | | | | | |
|---|---|---|---|---|---|
| TDD191 | Unassigned | Lu-69/(T.1/U:2) | Clay | n/a | n/a |
| TDD192 | Unassigned | | Clay | n/a | n/a |
| TDD193 | Unassigned | Pu-166/Bloque A/Kuel 8/ | Clay | n/a | n/a |
| TDD194 | Unassigned | Pu-166/Bloque A/Kuel 8/ | Clay | n/a | n/a |
| TDD195 | Unassigned | Pu-166/BloqueA/Kuel 8/Rasgo 3 | Clay | n/a | n/a |
| TDD196 | Unassigned | Lu-69/(T.1)/Capa7/Bolsa37 | Clay | n/a | n/a |
| TDD197 | Unassigned | Lu-69/Pozo1/Capa3/Bolsa13 | Clay | n/a | n/a |
| TDD198 | Unassigned | U.5/Capa 5 | Clay | n/a | n/a |
| TDD199 | Unassigned | Lu-54/Pozo 2/Suelo Rojo | Clay | n/a | n/a |
| TDD200 | Unassigned | Pu-166/BloqueA/Kuel8/ | Clay | n/a | n/a |
| TDD201 | Unassigned | Lu-69/(T.1/U:3)/Capa10/Bolsa38 | Clay | n/a | n/a |
| TDD202 | Unassigned | Lu-69/Pozo 1/Capa 2 | Clay | n/a | n/a |
| TDD203 | Unassigned | Lu-69/Bolsa 46/Camino | Clay | n/a | n/a |
| TDD204 | Unassigned | Lu-69/Pozo 3/Capa4 | Clay | n/a | n/a |
| TDD205 | Unassigned | Pu-166/BloqueA/Kuel8/Capa6 | Clay | n/a | n/a |
| TDD206 | Unassigned | Pu-166/Kuel8/T.1/Capa2 | Clay | n/a | n/a |
| TDD207 | Unassigned | Lu-69/(T.1/U:1)/Capa10/Bolsa34 | Clay | n/a | n/a |
| TDD208 | Unassigned | Lu-69/(T.1/U:1)/Capa13/N. 4.71 | Clay | n/a | n/a |
| TDD209 | Unassigned | Lu-69/(T.1/U:1)/Capa 10 | Clay | n/a | n/a |
| TDD210 | Unassigned | Lu-69/Pozo2/Capa1/Bolsa23 | Clay | n/a | n/a |
| TDD211 | Unassigned | Lu-69/Pozo 2/Capa 2 | Clay | n/a | n/a |
| TDD212 | Unassigned | Lu-69/(T.1/U:1)/Capa11/ | Clay | n/a | n/a |
| TDD213 | Unassigned | Lu-69/(T.1/U:1)/Capa 11/ | Clay | n/a | n/a |
| TDD214 | Unassigned | Pu-166/BloqueA/KueL8/Capa2 | Clay | n/a | n/a |

| | | | | | |
|---|---|---|---|---|---|
| TDD215 | Unassigned | Lu-69/Tren-Tren/Capa2 | Clay | n/a | n/a |
| TDD216 | Unassigned | Lu-69/Pozo3/N. 40-60 | Clay | n/a | n/a |
| TDD217 | Unassigned | Lu-69/Pozo1/Capa1/10-20cm | Clay | n/a | n/a |
| TDD218 | Unassigned | Lu-69/(T.1/U:1)/Bolsa 59 | Clay | n/a | n/a |
| TDD219 | Unassigned | Lu-69/Pozo 3/Capa 2 | Clay | n/a | n/a |
| TDD220 | Unassigned | Lu-69/(T.1/u:4)/Capa4/Bolsa5 | Clay | n/a | n/a |
| TDD221 | Unassigned | Lu-69/Pozo2/Capa1/0-20cm | Clay | n/a | n/a |
| TDD222 | Unassigned | Lu-69/(T.1/U:1)/Capa10/3-3.5 | Clay | n/a | n/a |
| TDD223 | Unassigned | Lu-69/Trin.1/N.4.40cm/Bolsa47 | Clay | n/a | n/a |
| TDD224 | Unassigned | Lu-69/(T.1/U:1)/N.9.80/Bolsa62 | Clay | n/a | n/a |
| TDD225 | Unassigned | Lu-69(T.1/U:1)/Capa 7/Bolsa 38 | Clay | n/a | n/a |
| TDD226 | Unassigned | Lu-69/Pozo 3/N. 137 | Clay | n/a | n/a |
| TDD227 | Unassigned | Lu-69/(T.1/U:4)/Capa9/Bolsa40 | Clay | n/a | n/a |
| TDD228 | Unassigned | Purén-Lumaco | Clay | n/a | n/a |
| TDD229 | Unassigned | Purén-Lumaco | Clay | n/a | n/a |
| TDD230 | Unassigned | Purén-Lumaco | Clay | n/a | n/a |
| TDD231 | Unassigned | Purén-Lumaco | Clay | n/a | n/a |
| TDD232 | Unassigned | Purén-Lumaco | Clay | n/a | n/a |
| TDD234 | Unassigned | Purén-Lumaco | Clay | n/a | n/a |
| TDD235 | Unassigned | Purén-Lumaco | Clay | n/a | n/a |
| TDD236 | Unassigned | Purén-Lumaco | Clay | n/a | n/a |
| TDD237 | Unassigned | Purén-Lumaco | Clay | n/a | n/a |
| TDD239 | Unassigned | Purén-Lumaco | Clay | n/a | n/a |
| TDD240 | Unassigned | Purén-Lumaco | Clay | n/a | n/a |

| | | | | | |
|---|---|---|---|---|---|
| TDD241 | Unassigned | Purén-Lumaco | Clay | n/a | n/a |
| TDD243 | Unassigned | Purén-Lumaco | Clay | n/a | n/a |
| TDD244 | Unassigned | Purén-Lumaco | Clay | n/a | n/a |
| TDD245 | Unassigned | Purén-Lumaco | Clay | n/a | n/a |
| TDD246 | Unassigned | Purén-Lumaco | Clay | n/a | n/a |
| TDD247 | Unassigned | Purén-Lumaco | Clay | n/a | n/a |
| TDD248 | Unassigned | Purén-Lumaco | Clay | n/a | n/a |
| TDD249 | Unassigned | Purén-Lumaco | Clay | n/a | n/a |
| TDD250 | Unassigned | Purén-Lumaco | Clay | n/a | n/a |
| TDD251 | Unassigned | Purén-Lumaco | Clay | n/a | n/a |
| TDD252 | Unassigned | Purén-Lumaco | Clay | n/a | n/a |
| TDD253 | Unassigned | Purén-Lumaco | Clay | n/a | n/a |
| TDD254 | Unassigned | Purén-Lumaco | Clay | n/a | n/a |
| TDD255 | Unassigned | Purén-Lumaco | Clay | n/a | n/a |
| TDD256 | Unassigned | Purén-Lumaco | Clay | n/a | n/a |
| TDD257 | Unassigned | Purén-Lumaco | Clay | n/a | n/a |
| TDD258 | Unassigned | Purén-Lumaco | Clay | n/a | n/a |
| TDD324 | Unassigned | | Clay | n/a | n/a |
| TDD325 | Unassigned | | Clay | n/a | n/a |
| TDD327 | Unassigned | PU 132 | Clay | n/a | n/a |
| TDD328 | Unassigned | PU 132 | Clay | n/a | n/a |
| TDD329 | Unassigned | Pu-166 | Clay | n/a | n/a |
| TDD330 | Unassigned | Pu-166 | Clay | n/a | n/a |
| TDD331 | Unassigned | | Clay | n/a | n/a |

| | | | | | |
|---|---|---|---|---|---|
| TDD332 | Unassigned | Lu-69 | Clay | n/a | n/a |

# Appendix IV, Table 2: Concentrations of Chemical Elements for INAA Samples.

| anid | Chemical Group | As | La | Lu | Nd | Sm | U | Yb | Ce | Co | Cr | Cs | Eu | Fe | Hf | Ni | Rb | Sb | Sc | Sr | Ta | Tb | Th | Zn | Zr | Al | Ba | Ca | Dy | K | Mn | Na | Ti | V |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TDD171 | Group 1 | 5.8938 | 14.2586 | 0.2787 | 18.5054 | 3.8589 | 0.9662 | 1.8694 | 31.6485 | 37.1236 | 681.4597 | 5.2510 | 1.1029 | 52733.2 | 4.3856 | 331.89 | 49.58 | 0.2942 | 24.5894 | 46.56 | 0.4103 | 0.4416 | 5.7618 | 135.30 | 116.98 | 103565.8 | 271.4 | 16913.7 | 3.2664 | 8553.0 | 707.29 | 3907.0 | 5483.9 | 178.69 |
| TDD173 | Group 1 | 10.7972 | 14.6347 | 0.2801 | 16.8955 | 3.9933 | 1.1185 | 2.0643 | 33.2868 | 39.4907 | 692.4975 | 3.9729 | 1.1132 | 53451.9 | 4.6251 | 282.36 | 52.35 | 0.4018 | 25.1578 | 0.00 | 0.3830 | 0.5928 | 5.8275 | 121.49 | 94.66 | 103093.2 | 164.0 | 17980.1 | 3.5818 | 7022.2 | 741.37 | 3777.6 | 6060.8 | 195.96 |
| TDD174 | Group 1 | 8.1134 | 16.1354 | 0.3082 | 17.4490 | 4.2882 | 1.7291 | 2.3793 | 38.3094 | 31.3435 | 340.0002 | 8.8929 | 1.1235 | 51562.6 | 5.5052 | 184.05 | 72.80 | 0.2839 | 21.4661 | 0.00 | 0.5311 | 0.5704 | 7.0612 | 106.66 | 187.00 | 96749.4 | 203.4 | 7926.3 | 3.8895 | 10002.0 | 747.77 | 4261.6 | 5367.2 | 160.82 |
| TDD175 | Group 1 | 11.8298 | 19.2296 | 0.3876 | 24.9349 | 5.0858 | 2.0332 | 2.6635 | 48.3873 | 27.7717 | 394.3997 | 5.5183 | 1.2582 | 75020.4 | 5.4546 | 210.17 | 45.97 | 0.4857 | 27.5355 | 0.00 | 0.6917 | 0.7484 | 6.8377 | 130.38 | 119.99 | 91104.5 | 379.6 | 5358.9 | 4.4033 | 7949.9 | 538.46 | 3955.4 | 7036.0 | 224.03 |
| TDD302 | Group 1 | 6.6807 | 8.7276 | 0.2853 | 8.2648 | 3.2391 | 0.0000 | 2.2007 | 17.8443 | 26.3181 | 512.7587 | 2.2504 | 0.8347 | 51227.3 | 2.8806 | 128.29 | 34.94 | 0.3129 | 32.4048 | 65.15 | 0.2685 | 0.5273 | 3.2308 | 86.26 | 0.00 | 106776.0 | 138.3 | 36980.4 | 3.6759 | 5684.4 | 461.61 | 11473.9 | 4630.5 | 226.00 |
| TDD335 | Group 1 | 5.6977 | 9.7888 | 0.2906 | 10.1887 | 3.1398 | 0.0000 | 2.1828 | 17.1903 | 34.4035 | 546.6964 | 2.1532 | 0.9389 | 60051.0 | 2.5602 | 177.41 | 41.41 | 0.2919 | 36.0760 | 83.36 | 0.3621 | 0.5131 | 2.8113 | 81.74 | 61.94 | 104018.5 | 534.3 | 34800.0 | 3.4375 | 6201.3 | 670.88 | 11748.8 | 4147.3 | 184.33 |
| TDD004 | Group 2 | 3.0454 | 27.6900 | 0.3086 | 28.3662 | 6.1044 | 3.3192 | 2.6803 | 58.6823 | 9.2185 | 18.5182 | 3.9341 | 1.6818 | 39149.8 | 12.4788 | 0.00 | 84.67 | 0.1988 | 20.3503 | 294.56 | 0.6968 | 0.7945 | 11.2549 | 60.95 | 333.24 | 108551.3 | 700.3 | 21417.4 | 4.4682 | 14818.3 | 394.40 | 13476.7 | 4069.0 | 94.87 |
| TDD010 | Group 2 | 2.9578 | 19.5920 | 0.2598 | 17.4894 | 3.9073 | 1.4441 | 1.7879 | 40.2916 | 9.4166 | 22.8116 | 4.3583 | 0.9893 | 34268.6 | 6.2245 | 0.00 | 95.82 | 0.2041 | 14.4294 | 301.99 | 0.6124 | 0.6209 | 9.7285 | 66.41 | 165.80 | 86563.4 | 1102.3 | 9610.3 | 2.9355 | 18323.8 | 338.81 | 14022.2 | 3166.0 | 80.75 |
| TDD013 | Group 2 | 3.3801 | 26.1487 | 0.3354 | 24.5562 | 5.1871 | 1.7790 | 2.4944 | 44.4295 | 6.3429 | 26.3254 | 4.0233 | 1.2207 | 40554.5 | 5.9994 | 0.00 | 91.41 | 0.2012 | 16.8090 | 179.72 | 0.7864 | 0.6858 | 11.2309 | 59.30 | 131.75 | 91745.4 | 965.9 | 9122.7 | 4.3054 | 18761.1 | 253.89 | 12839.8 | 4038.2 | 100.49 |
| TDD018 | Group 2 | 6.5206 | 24.9841 | 0.3018 | 20.3467 | 4.3639 | 2.0068 | 1.8922 | 53.3128 | 9.1424 | 20.9943 | 4.1264 | 1.0451 | 32823.2 | 7.0048 | 0.00 | 89.08 | 0.1991 | 13.3058 | 226.90 | 0.6641 | 0.5627 | 11.8227 | 70.24 | 176.17 | 77100.9 | 1359.3 | 7866.5 | 3.0702 | 16373.3 | 391.95 | 10176.7 | 2965.0 | 93.44 |
| TDD019 | Group 2 | 2.5512 | 18.3118 | 0.2871 | 17.9227 | 4.1518 | 0.9765 | 2.0423 | 33.2705 | 11.4107 | 18.8939 | 8.6207 | 0.9067 | 41326.8 | 4.2675 | 0.00 | 92.23 | 0.3681 | 20.3848 | 138.63 | 0.9448 | 0.4291 | 11.1053 | 74.78 | 96.94 | 102199.3 | 282.9 | 5576.1 | 2.7787 | 18167.5 | 542.53 | 10200.9 | 3149.8 | 93.82 |
| TDD023 | Group 2 | 5.2440 | 32.7229 | 0.4002 | 30.3033 | 6.4414 | 1.8685 | 2.8582 | 71.7117 | 23.9470 | 23.5232 | 3.5467 | 1.9129 | 47076.9 | 7.4246 | 0.00 | 72.87 | 0.1674 | 20.2921 | 190.12 | 1.1839 | 0.8324 | 11.2326 | 72.21 | 213.15 | 108044.2 | 1215.5 | 9907.6 | 5.3961 | 16174.5 | 596.70 | 6345.9 | 5436.5 | 135.53 |
| TDD025 | Group 2 | 3.3064 | 22.3090 | 0.2871 | 20.8350 | 4.7373 | 2.8912 | 2.1231 | 46.3778 | 7.0849 | 19.6773 | 2.4870 | 1.4620 | 29092.5 | 11.4224 | 0.00 | 66.87 | 0.1813 | 15.5117 | 299.55 | 0.8529 | 0.5388 | 9.4216 | 50.81 | 277.72 | 87919.4 | 1286.7 | 18336.7 | 3.8667 | 16106.4 | 329.18 | 10182.9 | 3461.6 | 85.31 |
| TDD033 | Group 2 | 3.0938 | 33.5689 | 0.1929 | 28.8419 | 5.3476 | 1.6708 | 1.5588 | 63.3230 | 7.0842 | 18.0187 | 4.3003 | 1.1978 | 41771.4 | 6.0319 | 0.00 | 98.48 | 0.5681 | 16.7037 | 161.31 | 0.5522 | 0.4888 | 9.4676 | 59.49 | 134.60 | 96522.2 | 1275.0 | 5088.9 | 3.4133 | 18122.8 | 275.81 | 18823.9 | 4150.2 | 89.36 |
| TDD038 | Group 2 | 1.8305 | 29.3944 | 0.3625 | 23.6991 | 5.7326 | 2.1336 | 2.3379 | 56.6802 | 9.6767 | 23.8515 | 4.7380 | 1.3004 | 39798.1 | 5.3441 | 0.00 | 94.67 | 0.2194 | 16.6935 | 258.31 | 0.7542 | 0.6365 | 10.6436 | 68.54 | 112.47 | 86602.3 | 901.5 | 10668.8 | 3.9680 | 17128.3 | 438.83 | 16447.5 | 2991.1 | 81.78 |
| TDD044 | Group 2 | 5.5211 | 23.8248 | 0.2559 | 22.1646 | 4.5074 | 1.9660 | 1.9065 | 50.3234 | 8.7822 | 24.4535 | 3.7187 | 1.1354 | 33220.5 | 6.6427 | 0.00 | 93.64 | 0.2008 | 14.2676 | 233.18 | 0.6651 | 0.5274 | 9.5864 | 55.33 | 154.55 | 80656.8 | 1161.6 | 9975.6 | 3.4588 | 18187.5 | 277.85 | 14700.2 | 3465.5 | 94.59 |
| TDD045 | Group 2 | 7.3441 | 44.3631 | 0.3629 | 37.6642 | 7.7157 | 2.1396 | 2.6521 | 146.1441 | 29.4704 | 21.1562 | 4.4614 | 1.7058 | 54173.4 | 7.7204 | 0.00 | 103.13 | 0.4385 | 21.6309 | 126.45 | 0.7507 | 0.9222 | 12.0698 | 78.59 | 158.76 | 101192.0 | 965.3 | 11805.8 | 3.9491 | 15808.9 | 1841.01 | 11817.7 | 3758.6 | 115.29 |
| TDD050 | Group 2 | 2.2658 | 32.5858 | 0.3577 | 31.4576 | 6.5390 | 2.6024 | 3.2268 | 61.5476 | 9.2245 | 26.3726 | 5.1415 | 1.3636 | 40501.4 | 5.7281 | 0.00 | 98.40 | 0.1740 | 16.9148 | 225.77 | 0.7603 | 0.6812 | 11.1715 | 78.24 | 117.93 | 88808.2 | 1008.6 | 12812.8 | 4.7850 | 17564.6 | 411.86 | 15422.0 | 3055.0 | 98.57 |
| TDD056 | Group 2 | 3.3432 | 29.9437 | 0.3740 | 24.9954 | 5.8543 | 2.1859 | 2.8193 | 58.2125 | 10.0093 | 25.1780 | 5.1137 | 1.2807 | 40481.1 | 5.5634 | 0.00 | 94.98 | 0.1961 | 17.1338 | 164.68 | 0.7254 | 0.6908 | 11.2227 | 76.57 | 124.20 | 85246.1 | 729.9 | 9945.4 | 4.2154 | 17221.5 | 393.77 | 14527.4 | 3355.8 | 104.90 |
| TDD057 | Group 2 | 2.2651 | 25.3417 | 0.3182 | 22.9314 | 5.0579 | 1.8719 | 2.0714 | 48.2045 | 9.0237 | 22.4652 | 5.3305 | 1.1473 | 36711.3 | 5.3084 | 0.00 | 102.53 | 0.2116 | 15.7980 | 236.74 | 0.6915 | 0.5291 | 9.6931 | 75.57 | 117.23 | 89605.2 | 817.3 | 9220.0 | 3.7354 | 20136.3 | 367.83 | 16190.3 | 3465.1 | 114.92 |
| TDD060 | Group 2 | 2.5139 | 23.3844 | 0.3566 | 24.6255 | 5.8852 | 1.9981 | 2.4834 | 51.9861 | 9.1810 | 23.6771 | 2.9901 | 1.6174 | 39079.6 | 8.6028 | 0.00 | 76.04 | 0.1170 | 19.6318 | 185.07 | 1.1189 | 0.8590 | 11.3158 | 53.10 | 204.70 | 109683.8 | 639.0 | 19569.7 | 4.6603 | 13287.4 | 632.86 | 11675.2 | 4192.5 | 104.98 |
| TDD061 | Group 2 | 9.7471 | 29.7481 | 0.4169 | 27.1942 | 6.1023 | 2.4122 | 2.5568 | 60.7752 | 11.9430 | 23.9615 | 5.0671 | 1.3830 | 41311.4 | 5.9120 | 0.00 | 101.76 | 0.1709 | 17.2393 | 156.52 | 0.7860 | 0.7110 | 11.0265 | 98.54 | 156.37 | 89649.3 | 976.2 | 6925.3 | 5.2257 | 22407.8 | 798.58 | 8993.0 | 3296.9 | 104.52 |
| TDD062 | Group 2 | 2.8507 | 24.7974 | 0.2698 | 22.5459 | 4.6859 | 1.4608 | 1.6791 | 67.1111 | 21.2476 | 22.1438 | 3.0839 | 1.4381 | 37817.8 | 7.6173 | 0.00 | 62.05 | 0.2219 | 18.6118 | 415.63 | 0.4643 | 0.5224 | 15.1469 | 84.52 | 202.18 | 110462.1 | 750.8 | 19818.6 | 3.2072 | 14347.3 | 507.80 | 12173.6 | 3148.0 | 97.27 |
| TDD063 | Group 2 | 2.1584 | 23.7194 | 0.3791 | 23.5151 | 6.5486 | 1.9127 | 2.7536 | 53.5833 | 9.5766 | 22.1476 | 3.2617 | 1.9168 | 36508.6 | 7.9929 | 0.00 | 70.48 | 0.1327 | 19.2089 | 279.42 | 0.6297 | 0.8839 | 9.3592 | 79.80 | 203.16 | 111061.7 | 649.9 | 26567.4 | 6.8262 | 13541.1 | 293.47 | 14564.1 | 4839.4 | 103.80 |
| TDD070 | Group 2 | 1.8483 | 30.3464 | 0.3522 | 25.8942 | 5.8548 | 1.7380 | 2.1609 | 65.4939 | 9.6168 | 24.5714 | 4.3167 | 1.3131 | 39473.0 | 5.7067 | 0.00 | 80.54 | 0.2103 | 16.4225 | 363.03 | 0.7737 | 0.6145 | 10.6260 | 69.18 | 134.56 | 85797.0 | 1269.0 | 13696.0 | 4.0709 | 15659.2 | 481.21 | 15270.7 | 3433.0 | 98.30 |
| TDD084 | Group 2 | 5.3639 | 38.9146 | 0.3392 | 35.1459 | 6.1903 | 2.0506 | 2.2636 | 82.7284 | 14.7942 | 19.7483 | 4.2944 | 1.5417 | 44867.4 | 8.5793 | 0.00 | 95.72 | 0.2917 | 18.1557 | 200.22 | 0.6809 | 0.6500 | 12.0702 | 66.56 | 202.33 | 94890.9 | 786.7 | 13040.9 | 4.3946 | 16732.2 | 685.08 | 12327.0 | 4901.0 | 112.85 |
| TDD095 | Group 2 | 3.8454 | 31.0242 | 0.4584 | 30.4156 | 7.8714 | 2.2532 | 3.1827 | 70.7566 | 12.8595 | 22.9813 | 2.5055 | 2.1871 | 40020.7 | 8.4206 | 0.00 | 73.48 | 0.1360 | 21.2672 | 333.32 | 0.5667 | 1.2323 | 11.8177 | 70.13 | 214.86 | 107092.8 | 1229.7 | 22618.5 | 6.8819 | 14775.8 | 659.41 | 12774.7 | 4014.1 | 106.15 |
| TDD100 | Group 2 | 5.2207 | 32.9044 | 0.4077 | 31.0181 | 6.6798 | 1.5782 | 3.1041 | 63.4349 | 13.2697 | 23.7032 | 3.5633 | 1.8401 | 47078.5 | 8.0401 | 0.00 | 68.40 | 0.1529 | 20.3128 | 147.45 | 0.6011 | 0.8612 | 11.4950 | 71.16 | 197.85 | 108572.8 | 792.3 | 9856.5 | 5.2181 | 14087.9 | 471.37 | 6156.5 | 5338.9 | 129.69 |
| TDD104 | Group 2 | 3.3713 | 29.1046 | 0.3157 | 24.8811 | 5.3970 | 2.1738 | 2.0679 | 57.2659 | 8.6767 | 26.5735 | 5.2219 | 1.1520 | 39189.5 | 5.2178 | 0.00 | 88.01 | 0.1929 | 15.6720 | 161.16 | 0.7777 | 0.5883 | 10.4754 | 68.97 | 132.58 | 89147.4 | 607.0 | 9689.1 | 3.7506 | 16650.9 | 298.30 | 15489.5 | 3379.1 | 112.99 |
| TDD109 | Group 2 | 3.0229 | 26.7922 | 0.3164 | 27.9819 | 5.6824 | 2.2896 | 2.6398 | 48.1914 | 6.3041 | 24.4493 | 4.7898 | 1.2250 | 38265.6 | 5.4642 | 0.00 | 89.21 | 0.1518 | 16.5524 | 357.09 | 0.7297 | 0.6776 | 11.2703 | 75.72 | 154.51 | 91860.5 | 1577.2 | 10311.9 | 4.4678 | 15675.0 | 366.07 | 13941.3 | 3295.2 | 99.36 |
| TDD114 | Group 2 | 2.4839 | 21.5023 | 0.3495 | 22.8383 | 5.1972 | 2.4807 | 2.3977 | 37.5891 | 8.2306 | 20.5466 | 2.4061 | 1.2779 | 35245.6 | 14.1523 | 0.00 | 59.96 | 0.2195 | 17.9487 | 274.30 | 0.6580 | 0.6973 | 8.9469 | 56.70 | 350.29 | 84967.5 | 1436.7 | 14460.3 | 4.4603 | 14014.5 | 526.86 | 8013.7 | 4205.6 | 93.31 |
| TDD119 | Group 2 | 3.7759 | 13.2318 | 0.1686 | 12.0814 | 2.5507 | 2.0367 | 1.0804 | 29.0306 | 8.3099 | 20.7286 | 4.2455 | 0.5791 | 37673.8 | 6.3361 | 0.00 | 107.58 | 0.0000 | 13.5657 | 118.93 | 0.6836 | 0.2238 | 9.6711 | 55.14 | 131.88 | 77949.3 | 677.0 | 3944.8 | 1.3732 | 19453.3 | 224.00 | 12987.5 | 3962.7 | 81.84 |
| TDD125 | Group 2 | 2.9060 | 30.3442 | 0.3287 | 28.0656 | 6.0794 | 2.3916 | 2.7127 | 59.8102 | 10.3076 | 24.6968 | 5.7882 | 1.2893 | 38850.3 | 6.0822 | 0.00 | 101.35 | 0.2162 | 16.8021 | 266.73 | 0.7830 | 0.7319 | 10.3385 | 87.58 | 155.09 | 84806.5 | 1008.0 | 13582.8 | 4.0343 | 19281.2 | 659.18 | 16243.4 | 3164.3 | 107.64 |
| TDD129 | Group 2 | 3.1575 | 22.9080 | 0.3262 | 22.6674 | 6.3831 | 2.4415 | 2.8641 | 51.5610 | 12.4230 | 20.4844 | 3.2097 | 1.7202 | 35564.1 | 8.6784 | 0.00 | 87.65 | 0.1380 | 17.2990 | 202.66 | 0.9091 | 1.0834 | 16.0331 | 84.22 | 210.63 | 106034.1 | 1079.2 | 17252.7 | 5.2579 | 20842.6 | 480.45 | 9139.3 | 3852.6 | 91.69 |
| TDD130 | Group 2 | 9.9073 | 31.3060 | 0.3925 | 31.4766 | 6.5948 | 3.1650 | 2.7186 | 67.1371 | 12.1443 | 24.9032 | 6.0805 | 1.3559 | 40740.2 | 4.8544 | 0.00 | 118.03 | 0.2515 | 17.6609 | 162.04 | 0.8371 | 0.9537 | 12.5572 | 100.62 | 136.97 | 90687.3 | 1015.3 | 6421.9 | 4.5235 | 27239.4 | 570.63 | 9821.5 | 3262.6 | 107.34 |
| TDD145 | Group 2 | 3.3265 | 20.2509 | 0.2919 | 21.8064 | 5.3605 | 2.1786 | 2.2674 | 43.9264 | 9.1016 | 23.3851 | 3.1803 | 1.4234 | 37036.3 | 9.9016 | 0.00 | 79.92 | 0.1327 | 17.4515 | 168.57 | 0.9076 | 0.7669 | 11.0241 | 59.95 | 244.36 | 106763.5 | 596.9 | 15489.6 | 4.2749 | 14740.4 | 289.41 | 9491.3 | 3910.6 | 96.41 |
| TDD147 | Group 2 | 3.7991 | 27.6974 | 0.2793 | 24.4433 | 5.3931 | 2.5982 | 2.2067 | 56.8659 | 11.3684 | 24.9075 | 4.5929 | 1.1614 | 39357.3 | 5.6807 | 0.00 | 90.18 | 0.1924 | 15.7248 | 245.29 | 0.7198 | 0.5938 | 10.8008 | 58.50 | 131.84 | 89889.2 | 941.4 | 10682.9 | 3.7215 | 16713.2 | 430.99 | 14286.9 | 3581.0 | 108.68 |
| TDD148 | Group 2 | 2.9903 | 21.0977 | 0.3163 | 24.2254 | 5.4104 | 3.0551 | 2.2760 | 45.1558 | 8.4270 | 20.0663 | 2.6388 | 1.4946 | 27785.2 | 9.0115 | 0.00 | 59.45 | 0.1526 | 16.0269 | 198.21 | 1.0099 | 0.7560 | 8.0263 | 37.03 | 229.43 | 90157.9 | 566.5 | 20549.0 | 4.2628 | 15836.8 | 387.94 | 12590.6 | 3504.0 | 94.09 |
| TDD167 | Group 2 | 2.6327 | 16.3491 | 0.2341 | 17.1039 | 3.7706 | 1.5475 | 1.6691 | 31.3519 | 10.9364 | 19.3934 | 8.2648 | 0.8126 | 40148.4 | 3.6441 | 0.00 | 92.90 | 0.3269 | 19.3144 | 93.87 | 0.9006 | 0.4740 | 9.7727 | 69.00 | 98.73 | 98911.3 | 339.5 | 6761.6 | 2.7080 | 18338.6 | 580.43 | 9947.2 | 3909.8 | 93.16 |
| TDD177 | Group 2 | 2.0552 | 17.6039 | 0.2654 | 20.1321 | 4.0521 | 2.2321 | 2.0843 | 32.3590 | 10.9503 | 19.2140 | 8.2377 | 0.8607 | 40180.3 | 4.3432 | 0.00 | 88.15 | 0.3607 | 19.8719 | 111.77 | 0.9132 | 0.4568 | 10.5659 | 71.48 | 112.95 | 100877.6 | 361.1 | 5768.8 | 2.8863 | 18600.8 | 589.18 | 10196.9 | 3267.6 | 94.40 |
| TDD183 | Group 2 | 0.0000 | 16.8721 | 0.2616 | 18.5532 | 3.9029 | 1.3359 | 1.6943 | 28.7564 | 9.8592 | 16.9841 | 7.6422 | 0.8248 | 38249.5 | 4.4655 | 0.00 | 80.84 | 0.3812 | 19.0876 | 82.35 | 0.8805 | 0.4580 | 10.3371 | 65.34 | 106.97 | 97414.6 | 294.2 | 5142.2 | 2.4868 | 19722.5 | 536.39 | 10210.7 | 3711.3 | 96.31 |
| TDD260 | Group 2 | 2.7317 | 17.2412 | 0.2685 | 16.8831 | 4.2205 | 2.9027 | 1.8411 | 63.1759 | 15.4619 | 20.2254 | 2.7102 | 1.2260 | 31697.5 | 7.8407 | 0.00 | 66.55 | 0.1532 | 16.4554 | 206.16 | 1.7410 | 0.5658 | 7.3924 | 42.51 | 204.45 | 102593.7 | 622.2 | 21053.5 | 2.6070 | 11902.5 | 950.72 | 13925.4 | 4170.0 | 106.91 |
| TDD267 | Group 2 | 2.2099 | 30.8895 | 0.4047 | 33.3933 | 7.0155 | 1.9946 | 3.2707 | 73.2624 | 10.2327 | 17.1262 | 3.4505 | 2.0708 | 34550.9 | 14.8466 | 0.00 | 91.60 | 0.2182 | 20.4360 | 245.64 | 1.1701 | 1.2355 | 11.1775 | 64.99 | 373.45 | 103418.6 | 884.2 | 22945.1 | 5.1239 | 18110.9 | 709.73 | 15172.5 | 4292.4 | 83.12 |
| TDD268 | Group 2 | 3.0586 | 24.5973 | 0.3897 | 27.6170 | 6.2455 | 1.8444 | 2.9009 | 60.4579 | 10.4125 | 22.6104 | 3.0261 | 1.8410 | 36167.5 | 10.0204 | 37.70 | 74.32 | 0.1159 | 18.1267 | 200.76 | 0.7257 | 1.0564 | 10.0131 | 67.46 | 263.85 | 108672.2 | 620.5 | 27068.2 | 5.0702 | 12193.1 | 398.60 | 15135.9 | 4167.9 | 93.02 |
| TDD269 | Group 2 | 2.3146 | 31.0805 | 0.3413 | 30.9862 | 6.5150 | 1.9274 | 2.4978 | 73.5905 | 11.7503 | 17.8532 | 4.8328 | 1.7911 | 40475.7 | 10.0498 | 0.00 | 94.29 | 0.1343 | 20.3661 | 226.58 | 0.7762 | 1.0005 | 10.4148 | 73.97 | 236.84 | 111002.5 | 456.3 | 22635.0 | 4.9435 | 12902.1 | 626.93 | 14356.9 | 3736.6 | 89.28 |
| TDD270 | Group 2 | 2.7884 | 22.8222 | 0.3772 | 24.5285 | 6.0658 | 1.8990 | 2.9758 | 54.0507 | 9.4139 | 20.4386 | 2.5188 | 1.8075 | 34543.7 | 8.4601 | 0.00 | 69.33 | 0.1012 | 18.6288 | 212.62 | 0.7109 | 0.9133 | 10.8004 | 59.06 | 190.09 | 105791.6 | 573.2 | 23546.6 | 5.0278 | 14341.7 | 423.83 | 13011.6 | 4127.3 | 91.39 |
| TDD271 | Group 2 | 2.0665 | 28.3150 | 0.3284 | 27.5686 | 5.4621 | 2.2341 | 2.3499 | 68.5495 | 10.8495 | 16.4411 | 3.8594 | 1.6360 | 33145.9 | 12.3381 | 0.00 | 83.51 | 0.1862 | 19.1650 | 309.11 | 0.6672 | 0.6464 | 10.8985 | 70.51 | 273.63 | 105495.5 | 570.5 | 26556.1 | 4.2931 | 12299.1 | 506.18 | 16066.2 | 3626.4 | 85.77 |
| TDD272 | Group 2 | 2.8500 | 29.0397 | 0.3069 | 28.4530 | 5.0963 | 1.5854 | 1.9664 | 80.6261 | 8.8663 | 16.2231 | 3.6231 | 1.5391 | 41710.1 | 10.6367 | 0.00 | 84.46 | 0.1725 | 19.6000 | 269.15 | 0.4564 | 0.6254 | 12.0918 | 81.41 | 272.09 | 113379.7 | 636.9 | 24643.5 | 3.2541 | 13794.7 | 347.27 | 16298.5 | 3751.6 | 85.34 |
| TDD273 | Group 2 | 3.0126 | 27.4977 | 0.3556 | 29.0809 | 5.9108 | 2.1113 | 2.7332 | 64.1313 | 11.0061 | 17.2271 | 3.4380 | 1.7467 | 39919.4 | 12.5708 | 0.00 | 86.67 | 0.2133 | 19.7792 | 193.17 | 0.9362 | 0.9727 | 11.6479 | 70.14 | 325.04 | 101289.8 | 640.2 | 21823.5 | 4.8081 | 14603.4 | 586.82 | 13442.1 | 3868.0 | 84.30 |
| TDD274 | Group 2 | 5.1413 | 27.0099 | 0.3667 | 35.6135 | 6.1637 | 2.1206 | 2.5748 | 64.3444 | 10.6315 | 22.6985 | 4.0306 | 1.7074 | 40358.1 | 11.1502 | 0.00 | 87.11 | 0.1730 | 20.1936 | 209.46 | 0.7465 | 0.8177 | 11.3645 | 85.91 | 284.14 | 108173.1 | 705.9 | 21326.6 | 5.6839 | 18919.2 | 625.47 | 13001.4 | 4119.6 | 101.47 |
| TDD275 | Group 2 | 2.0875 | 35.9995 | 0.4208 | 31.8035 | 7.1755 | 2.4468 | 3.3313 | 80.1478 | 11.8679 | 19.0174 | 4.4738 | 2.1338 | 37243.6 | 14.8443 | 0.00 | 113.80 | 0.1710 | 21.8994 | 276.57 | 0.6713 | 1.2254 | 11.9593 | 71.62 | 360.88 | 101117.7 | 816.4 | 20059.1 | 6.0579 | 14809.3 | 626.54 | 11881.1 | 3803.2 | 103.62 |
| TDD276 | Group 2 | 3.0020 | 30.6604 | 0.4204 | 32.3252 | 6.7776 | 1.9718 | 3.2899 | 61.6970 | 10.6326 | 19.6326 | 3.6753 | 2.0198 | 38215.1 | 12.6585 | 0.00 | 96.47 | 0.1750 | 19.6953 | 259.37 | 0.6602 | 1.2000 | 10.6785 | 69.49 | 302.65 | 88432.0 | 564.5 | 10666.4 | 3.9396 | 18252.5 | 482.82 | 15046.6 | 3551.0 | 128.73 |
| TDD278 | Group 2 | 2.5562 | 25.0331 | 0.3933 | 26.9708 | 5.2752 | 1.9691 | 2.5987 | 56.4270 | 8.0470 | 17.0377 | 3.3036 | 1.5855 | 34622.3 | 11.2314 | 0.00 | 76.00 | 0.1442 | 18.1292 | 291.82 | 0.6420 | 0.6593 | 9.5230 | 60.61 | 265.35 | 98005.1 | 436.0 | 28576.0 | 4.7644 | 16606.0 | 867.63 | 13944.9 | 5069.6 | 182.38 |
| TDD282 | Group 2 | 3.1196 | 29.6224 | 0.4387 | 28.0383 | 6.2354 | 1.7574 | 3.0006 | 59.6583 | 10.0163 | 17.2698 | 3.4336 | 1.7917 | 33909.6 | 14.1486 | 0.00 | 90.46 | 0.1563 | 19.4039 | 239.90 | 0.4860 | 1.0544 | 10.8155 | 63.32 | 334.74 | 95270.1 | 622.8 | 13654.8 | 6.4786 | 15664.0 | 511.43 | 8001.6 | 5118.8 | 142.63 |
| TDD286 | Group 2 | 2.8541 | 32.4627 | 0.4104 | 32.7032 | 7.3145 | 2.7601 | 3.2962 | 79.3757 | 12.0101 | 17.7636 | 3.7420 | 1.8870 | 37382.2 | 9.5327 | 0.00 | 91.47 | 0.1700 | 20.4152 | 285.41 | 0.8789 | 1.1799 | 10.4216 | 71.72 | 245.49 | 110466.8 | 669.4 | 26071.9 | 5.7396 | 15940.2 | 755.20 | 16755.2 | 3976.6 | 92.25 |
| TDD290 | Group 2 | 2.3315 | 28.2469 | 0.3481 | 29.1892 | 6.0584 | 1.2199 | 2.5571 | 52.1394 | 8.1921 | 23.0370 | 2.8680 | 1.6128 | 38275.4 | 7.7124 | 0.00 | 69.61 | 0.0916 | 19.2698 | 211.93 | 0.3816 | 0.9575 | 15.2299 | 66.20 | 181.22 | 117553.7 | 600.1 | 24884.6 | 5.0645 | 12855.1 | 228.73 | 14743.5 | 4117.4 | 98.84 |
| TDD291 | Group 2 | 5.9428 | 40.3542 | 0.2366 | 35.2815 | 6.3229 | 2.0196 | 2.3007 | 92.8413 | 14.9915 | 19.9393 | 6.0803 | 1.4425 | 47908.8 | 6.5201 | 0.00 | 121.61 | 0.3341 | 18.9495 | 138.22 | 0.7300 | 0.6095 | 11.2023 | 91.91 | 148.96 | 96272.6 | 789.0 | 12943.9 | 3.9036 | 17965.8 | 670.29 | 12327.2 | 4405.9 | 96.55 |
| TDD292 | Group 2 | 2.7935 | 24.5955 | 0.3193 | 25.4148 | 5.1565 | 1.9258 | 2.7294 | 52.8864 | 11.7462 | 24.3722 | 5.9104 | 1.1301 | 37979.8 | 6.0904 | 82.61 | 105.85 | 0.2437 | 17.5118 | 155.88 | 0.7077 | 0.6578 | 11.1508 | 76.90 | 117.68 | 89654.1 | 534.0 | 8684.9 | 3.7099 | 20070.4 | 402.77 | 15638.0 | 2844.5 | 101.00 |
| TDD296 | Group 2 | 2.7672 | 25.4891 | 0.2927 | 29.7063 | 5.8512 | 1.5743 | 2.1615 | 54.9302 | 9.0596 | 23.6332 | 2.3618 | 1.5390 | 35392.8 | 9.2612 | 0.00 | 68.96 | 0.1072 | 18.0506 | 184.13 | 0.5334 | 0.6650 | 9.7595 | 66.99 | 224.41 | 103287.9 | 663.5 | 23032.2 | 4.0352 | 16271.9 | 276.11 | 13144.3 | 3639.7 | 102.95 |
| TDD297 | Group 2 | 2.0964 | 26.9493 | 0.3748 | 29.6969 | 5.8418 | 2.2587 | 2.8479 | 54.4236 | 8.5585 | 14.9457 | 3.0753 | 1.7615 | 30417.0 | 12.8020 | 0.00 | 82.97 | 0.1280 | 17.9623 | 315.20 | 0.6649 | 0.8255 | 10.0581 | 54.11 | 295.74 | 100322.4 | 747.8 | 24811.4 | 4.3937 | 15764.0 | 433.13 | 17367.4 | 3611.9 | 58.12 |
| TDD298 | Group 2 | 2.7891 | 19.2543 | 0.3775 | 19.2288 | 5.4976 | 2.4168 | 2.9988 | 50.4414 | 9.2138 | 22.0537 | 3.5399 | 1.4880 | 39861.4 | 11.3052 | 0.00 | 85.20 | 0.2270 | 19.9168 | 137.96 | 0.5828 | 0.8876 | 9.7954 | 68.01 | 270.72 | 101805.5 | 635.2 | 17765.8 | 4.6974 | 16626.7 | 496.34 | 10457.3 | 4606.6 | 91.56 |
| TDD299 | Group 2 | 2.2173 | 20.3542 | 0.4289 | 27.2472 | 6.0858 | 2.4870 | 2.9897 | 53.9161 | 9.7794 | 22.4959 | 3.4838 | 1.6035 | 41178.2 | 13.3268 | 0.00 | 81.95 | 0.1601 | 21.9937 | 175.05 | 0.6117 | 1.0342 | 9.8419 | 71.26 | 331.59 | 104355.2 | 579.6 | 18485.1 | 5.1796 | 13525.0 | 500.46 | 10625.1 | 4046.9 | 102.30 |
| TDD304 | Group 2 | 2.1836 | 24.2029 | 0.3762 | 24.8123 | 6.0834 | 2.6362 | 2.7183 | 50.9288 | 7.0954 | 16.8171 | 3.8315 | 1.7572 | 33908.8 | 12.7822 | 0.00 | 79.50 | 0.2029 | 20.1094 | 222.12 | 0.8055 | 0.9685 | 10.9618 | 63.71 | 334.08 | 108927.1 | 655.0 | 24413.3 | 5.0957 | 15196.3 | 336.51 | 15221.4 | 3931.2 | 87.52 |
| TDD305 | Group 2 | 2.1593 | 24.0244 | 0.3937 | 23.4699 | 5.7469 | 2.1439 | 2.4781 | 47.6358 | 7.4614 | 15.9575 | 3.6540 | 1.5962 | 33012.3 | 13.1975 | 0.00 | 77.73 | 0.1754 | 19.8896 | 225.97 | 0.7795 | 0.6906 | 10.4543 | 64.09 | 332.24 | 104307.5 | 544.4 | 22218.8 | 4.6123 | 14427.4 | 334.36 | 14633.5 | 3897.4 | 82.06 |
| TDD306 | Group 2 | 2.6056 | 21.0387 | 0.3212 | 30.3342 | 5.8926 | 2.1835 | 2.6124 | 50.2961 | 15.8006 | 21.6214 | 2.9437 | 1.5088 | 37174.4 | 11.0082 | 0.00 | 70.81 | 0.1353 | 20.4292 | 266.13 | 0.7154 | 1.0051 | 9.8059 | 66.23 | 277.17 | 103538.3 | 586.8 | 23515.5 | 4.7635 | 14248.5 | 466.36 | 14294.4 | 3972.3 | 103.60 |
| TDD307 | Group 2 | 1.5182 | 30.4955 | 0.3052 | 31.6207 | 5.9401 | 1.6904 | 2.4134 | 56.1544 | 7.7100 | 16.4123 | 4.3224 | 1.6992 | 37132.9 | 9.1351 | 0.00 | 80.63 | 0.1726 | 19.8811 | 251.24 | 0.6243 | 0.7091 | 10.5102 | 67.44 | 243.95 | 110679.7 | 605.9 | 25069.8 | 3.9411 | 14337.6 | 451.26 | 16725.7 | 3660.7 | 78.18 |
| TDD308 | Group 2 | 1.7499 | 27.1127 | 0.3986 | 32.4284 | 6.3412 | 3.2091 | 2.8991 | 53.4673 | 7.1353 | 17.2690 | 3.8478 | 1.7777 | 35227.0 | 12.3971 | 0.00 | 81.80 | 0.2324 | 20.9988 | 297.56 | 1.6330 | 0.8353 | 11.5703 | 64.59 | 303.27 | 107039.0 | 593.3 | 24162.0 | 5.4404 | 16831.6 | 438.78 | 14834.7 | 4279.0 | 95.56 |
| TDD309 | Group 2 | 2.0378 | 22.7911 | 0.2871 | 23.6244 | 5.4239 | 2.0763 | 2.2124 | 49.6354 | 10.2611 | 18.2560 | 4.4013 | 1.6140 | 37733.0 | 12.6649 | 0.00 | 87.98 | 0.1561 | 19.4480 | 310.41 | 0.5665 | 0.7270 | 11.0772 | 58.79 | 265.77 | 112137.3 | 739.5 | 20910.6 | 3.5447 | 15504.0 | 415.99 | 14179.2 | 4247.2 | 79.70 |
| TDD311 | Group 2 | 2.7068 | 19.7029 | 0.2942 | 22.6699 | 5.4747 | 2.3489 | 2.3401 | 44.4557 | 9.5458 | 21.0790 | 2.6947 | 1.5082 | 37381.2 | 9.9527 | 0.00 | 79.80 | 0.1405 | 19.1150 | 216.66 | 0.8924 | 0.7506 | 9.6933 | 53.33 | 214.48 | 104935.8 | 669.2 | 21398.0 | 4.5059 | 17311.6 | 461.02 | 12809.9 | 4681.4 | 100.43 |
| TDD322 | Group 2 | 4.0818 | 24.1992 | 0.3426 | 22.8562 | 5.7580 | 2.2436 | 2.5195 | 54.7920 | 12.2740 | 16.9501 | 2.8232 | 1.8110 | 34904.4 | 13.6832 | 0.00 | 73.34 | 0.1572 | 19.3894 | 345.74 | 0.5528 | 1.0589 | 9.4131 | 59.68 | 370.37 | 100716.6 | 648.4 | 26457.5 | 4.4222 | 13345.7 | 821.79 | 16236.1 | 3258.2 | 65.32 |
| TDD342 | Group 2 | 2.8114 | 42.1413 | 0.5337 | 44.3064 | 10.3049 | 2.9294 | 4.2287 | 95.8109 | 12.4364 | 26.6581 | 4.0567 | 2.7721 | 42814.1 | 6.0982 | 0.00 | 99.56 | 0.1217 | 21.8231 | 161.10 | 0.8379 | 1.5739 | 13.4032 | 79.48 | 159.17 | 114588.9 | 602.3 | 17874.2 | 8.9451 | 16243.6 | 751.96 | 9919.1 | 5278.8 | 135.52 |
| TDD345 | Group 2 | 0.0000 | 24.4511 | 0.3384 | 24.9636 | 5.3525 | 2.2180 | 2.2255 | 49.2136 | 8.7948 | 17.4663 | 3.6379 | 1.5695 | 33389.5 | 12.8880 | 34.80 | 82.58 | 0.1666 | 17.0302 | 263.01 | 0.5209 | 0.7265 | 8.5423 | 51.05 | 298.00 | 107745.7 | 650.2 | 24740.5 | 4.8584 | 14466.8 | 435.23 | 15093.8 | 3938.4 | 90.56 |
| TDD355 | Group 2 | 0.0000 | 38.2672 | 0.5116 | 39.3068 | 9.1876 | 2.9583 | 4.1024 | 78.4007 | 10.1750 | 25.1869 | 3.1507 | 2.4890 | 40029.1 | 7.5057 | 0.00 | 94.09 | 0.1042 | 20.9816 | 293.80 | 0.8441 | 1.4265 | 14.1198 | 72.43 | 207.74 | 116127.1 | 1008.5 | 21160.4 | 8.7581 | 16491.9 | 758.30 | 12055.6 | 4902.0 | 119.86 |
| TDD357 | Group 2 | 4.3779 | 30.9155 | 0.3168 | 28.0873 | 5.9436 | 2.6141 | 2.5590 | 64.1698 | 10.1322 | 27.4915 | 5.2900 | 1.2479 | 44543.3 | 5.1275 | 0.00 | 91.65 | 0.2055 | 18.4812 | 132.90 | 0.8877 | 0.7480 | 11.0155 | 87.21 | 135.86 | 100864.4 | 572.4 | 11585.1 | 4.3017 | 14811.4 | 463.75 | 15159.4 | 3525.0 | 103.69 |
| TDD001 | Group 3 | 5.5562 | 23.8778 | 0.3611 | 24.1615 | 5.0651 | 0.7825 | 2.6574 | 45.2281 | 18.8456 | 52.7897 | 8.2030 | 1.1082 | 58157.4 | 7.4762 | 0.00 | 95.11 | 0.2332 | 24.9052 | 167.25 | 0.7856 | 0.7781 | 9.5579 | 82.43 | 175.51 | 96705.8 | 465.4 | 17657.4 | 4.5651 | 12442.0 | 859.26 | 12399.3 | 5094.3 | 211.47 |
| TDD002 | Group 3 | 6.7105 | 21.2113 | 0.3522 | 22.4816 | 5.3765 | 1.9124 | 2.8170 | 47.5967 | 22.9804 | 63.7585 | 4.1597 | 1.1630 | 46783.4 | 8.5960 | 0.00 | 88.64 | 0.1672 | 20.6970 | 243.34 | 0.5931 | 0.6870 | 6.5633 | 71.42 | 188.07 | 91476.6 | 921.2 | 18617.8 | 4.0344 | 13077.3 | 856.20 | 8962.0 | 4283.3 | 143.65 |
| TDD003 | Group 3 | 6.5469 | 27.8021 | 0.4421 | 28.5049 | 6.7702 | 1.2291 | 3.4562 | 60.8482 | 20.3360 | 42.5350 | 6.9427 | 1.4629 | 55044.8 | 5.0071 | 0.00 | 79.64 | 0.1646 | 26.2716 | 362.40 | 0.6928 | 1.0024 | 8.1264 | 104.51 | 171.50 | 97293.9 | 1365.5 | 16591.4 | 5.7902 | 16773.1 | 813.88 | 11481.4 | 4701.1 | 170.38 |

| anid | Chemical Group | As | La | Lu | Nd | Sm | U | Yb | Ce | Co | Cr | Cs | Eu | Fe | Hf | Ni | Rb | Sb | Sc | Sr | Ta | Tb | Th | Zn | Zr | Al | Ba | Ca | Dy | K | Mn | Na | Ti | V |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TDD005 | Group 3 | 4.5010 | 27.6635 | 0.4481 | 30.7443 | 6.6893 | 0.8489 | 3.3330 | 57.9694 | 17.2009 | 42.0796 | 7.7310 | 1.4527 | 55195.3 | 5.6710 | 0.00 | 86.89 | 0.2738 | 25.8585 | 268.74 | 0.7308 | 1.2308 | 8.9962 | 106.45 | 161.52 | 102655.3 | 1175.4 | 19044.4 | 5.7414 | 11456.0 | 700.07 | 11812.0 | 5237.0 | 187.58 |
| TDD006 | Group 3 | 5.3507 | 33.9039 | 0.4338 | 28.8418 | 7.1620 | 2.9433 | 3.0633 | 74.7365 | 16.3858 | 43.4977 | 4.5976 | 1.6489 | 49838.2 | 7.7233 | 0.00 | 72.01 | 0.2692 | 23.1294 | 217.59 | 0.7814 | 0.8133 | 12.9351 | 93.02 | 180.19 | 100841.1 | 863.1 | 20768.3 | 5.4992 | 13071.4 | 566.18 | 10885.7 | 4775.7 | 166.27 |
| TDD008 | Group 3 | 4.3989 | 26.7046 | 0.4245 | 27.1835 | 5.8778 | 1.4833 | 3.0866 | 53.4161 | 16.7139 | 39.7715 | 7.2973 | 1.3489 | 53561.9 | 5.1316 | 0.00 | 90.81 | 0.1930 | 23.9826 | 236.88 | 0.7063 | 0.7901 | 8.2329 | 99.51 | 122.35 | 94929.0 | 874.2 | 16112.8 | 5.4521 | 13379.3 | 685.90 | 10864.2 | 3989.6 | 171.23 |
| TDD011 | Group 3 | 6.3323 | 34.1933 | 0.5021 | 28.2034 | 7.0645 | 2.1171 | 3.7595 | 74.3318 | 20.5839 | 67.2124 | 3.4441 | 1.6864 | 43939.1 | 6.2117 | 44.15 | 69.93 | 0.2582 | 19.2234 | 281.14 | 0.6891 | 0.9660 | 9.8442 | 71.29 | 173.58 | 87158.3 | 1233.7 | 13054.5 | 5.9347 | 13751.6 | 801.89 | 7950.6 | 5362.5 | 125.27 |
| TDD012 | Group 3 | 4.3867 | 21.4631 | 0.3611 | 27.6837 | 5.3356 | 1.2737 | 2.4721 | 60.9921 | 24.9853 | 60.6278 | 3.5897 | 1.2332 | 49059.2 | 6.2420 | 0.00 | 85.84 | 0.2518 | 21.2033 | 267.96 | 0.8517 | 0.6602 | 7.2012 | 77.66 | 159.56 | 84423.6 | 1224.0 | 17553.9 | 4.4832 | 14730.1 | 1524.55 | 7928.1 | 4364.0 | 145.04 |
| TDD014 | Group 3 | 4.1854 | 19.1280 | 0.3777 | 19.6504 | 4.9122 | 1.6873 | 2.4871 | 41.5052 | 21.7821 | 62.2855 | 4.1676 | 1.1144 | 47596.8 | 6.9239 | 0.00 | 88.61 | 0.1864 | 22.4524 | 213.76 | 0.5662 | 0.7975 | 7.8152 | 82.39 | 154.23 | 87762.6 | 881.2 | 19660.5 | 4.2780 | 13385.4 | 1116.62 | 8440.3 | 3997.1 | 149.04 |
| TDD016 | Group 3 | 5.6473 | 22.4333 | 0.3653 | 20.0343 | 5.2507 | 1.3374 | 2.8440 | 53.2188 | 17.8887 | 36.9690 | 5.1573 | 1.2011 | 55919.8 | 5.0797 | 0.00 | 78.48 | 0.2158 | 25.5667 | 148.79 | 0.6396 | 0.6662 | 6.8653 | 90.77 | 119.69 | 101976.2 | 768.5 | 10346.4 | 5.1853 | 13012.0 | 710.95 | 11059.6 | 5114.4 | 178.01 |
| TDD020 | Group 3 | 4.7643 | 22.9640 | 0.4019 | 25.1313 | 5.9328 | 1.6881 | 2.9294 | 47.4297 | 18.8341 | 41.7257 | 3.5961 | 1.4759 | 60613.1 | 5.7073 | 0.00 | 54.68 | 0.2404 | 26.5654 | 278.76 | 0.7374 | 0.9344 | 6.5471 | 97.07 | 134.09 | 106488.9 | 757.2 | 26225.0 | 4.9164 | 10356.6 | 799.49 | 11399.0 | 6289.7 | 172.66 |
| TDD021 | Group 3 | 2.2367 | 23.5996 | 0.4280 | 22.5928 | 5.7872 | 1.0203 | 3.1538 | 50.6767 | 16.7638 | 40.8296 | 7.0980 | 1.2632 | 54823.9 | 5.4002 | 0.00 | 90.25 | 0.1831 | 24.4934 | 276.71 | 0.6773 | 0.7726 | 7.6823 | 88.80 | 138.03 | 91611.2 | 596.8 | 11327.8 | 4.9642 | 15280.2 | 779.26 | 15325.2 | 4930.1 | 183.86 |
| TDD022 | Group 3 | 4.8590 | 20.4383 | 0.3270 | 24.2453 | 5.1931 | 1.2653 | 2.3594 | 45.4754 | 22.3152 | 63.7092 | 4.1960 | 1.1566 | 48678.6 | 7.0670 | 0.00 | 90.04 | 0.1856 | 21.6854 | 156.96 | 0.6268 | 0.6380 | 6.8431 | 76.91 | 144.64 | 87056.4 | 1021.7 | 17183.4 | 5.0255 | 13032.1 | 953.87 | 7396.4 | 4540.7 | 154.21 |
| TDD026 | Group 3 | 5.2492 | 23.6819 | 0.5063 | 25.4213 | 6.1596 | 1.9201 | 3.5534 | 51.4086 | 18.2770 | 33.3794 | 4.8216 | 1.2816 | 41151.7 | 11.6272 | 0.00 | 95.98 | 0.1902 | 24.5041 | 194.64 | 0.6857 | 1.0130 | 15.5445 | 83.76 | 287.31 | 79267.1 | 814.1 | 13433.8 | 5.5671 | 16046.4 | 1084.98 | 13243.5 | 4309.9 | 135.71 |
| TDD027 | Group 3 | 3.1717 | 22.0146 | 0.3195 | 20.0402 | 5.1104 | 2.0340 | 2.4129 | 43.1058 | 10.9512 | 46.8455 | 3.3997 | 1.2639 | 44601.6 | 6.2431 | 0.00 | 80.77 | 0.1878 | 24.2576 | 185.54 | 0.7309 | 0.6243 | 7.4883 | 84.49 | 162.45 | 98912.2 | 747.1 | 22223.9 | 4.6064 | 12841.5 | 436.52 | 10729.2 | 4916.1 | 137.12 |
| TDD028 | Group 3 | 2.3296 | 16.0154 | 0.2326 | 16.2998 | 3.3661 | 1.6336 | 1.6081 | 34.3343 | 7.3078 | 36.6203 | 3.6091 | 0.7818 | 34896.6 | 5.7995 | 0.00 | 127.82 | 0.4838 | 16.3192 | 190.64 | 0.6945 | 0.4177 | 7.3389 | 85.77 | 146.78 | 89065.2 | 993.2 | 10030.8 | 2.7650 | 22831.7 | 351.79 | 7442.5 | 4650.2 | 139.17 |
| TDD029 | Group 3 | 2.9123 | 20.7605 | 0.3717 | 24.6823 | 5.6680 | 1.7118 | 2.8267 | 48.1195 | 19.8597 | 74.7129 | 2.7078 | 1.4015 | 55570.3 | 5.7915 | 0.00 | 43.69 | 0.1750 | 28.8000 | 259.44 | 0.7776 | 0.7466 | 3.8462 | 97.65 | 129.71 | 91115.0 | 543.9 | 35219.4 | 4.7281 | 6936.6 | 1062.21 | 13140.8 | 6084.7 | 180.27 |
| TDD031 | Group 3 | 5.1732 | 22.8912 | 0.3591 | 23.5870 | 5.0589 | 2.7085 | 2.4583 | 59.2469 | 20.8533 | 70.4982 | 6.1438 | 1.1463 | 48853.8 | 7.4125 | 0.00 | 145.42 | 0.3264 | 17.3990 | 117.50 | 0.7605 | 0.6143 | 10.3598 | 89.20 | 158.01 | 92927.2 | 1282.1 | 6833.4 | 4.1389 | 19148.0 | 918.41 | 3618.3 | 4321.5 | 138.91 |
| TDD035 | Group 3 | 2.1603 | 22.0110 | 0.3686 | 27.2073 | 5.1663 | 1.1699 | 2.4599 | 42.3481 | 11.9641 | 33.2113 | 2.9117 | 1.3564 | 42000.2 | 7.1871 | 0.00 | 68.23 | 0.1443 | 19.3143 | 309.91 | 0.5645 | 0.6503 | 5.7425 | 66.98 | 159.10 | 99293.0 | 569.5 | 28697.3 | 4.2643 | 11804.3 | 596.16 | 15115.4 | 4305.8 | 140.33 |
| TDD036 | Group 3 | 3.9787 | 26.5119 | 0.4578 | 23.4244 | 6.0297 | 0.9911 | 3.3709 | 58.6929 | 20.5234 | 39.6972 | 5.8570 | 1.3831 | 58088.3 | 5.3142 | 0.00 | 93.61 | 0.2134 | 27.3178 | 190.88 | 0.7420 | 0.8489 | 7.4215 | 100.51 | 126.73 | 95854.4 | 1044.9 | 11779.4 | 5.6678 | 13648.9 | 734.27 | 13245.7 | 5598.9 | 172.49 |
| TDD037 | Group 3 | 5.8706 | 23.3602 | 0.3388 | 25.3828 | 5.0606 | 2.2938 | 2.6057 | 51.5565 | 14.4707 | 73.3563 | 4.6158 | 1.1263 | 47324.4 | 8.4556 | 0.00 | 84.25 | 0.2797 | 19.5930 | 150.77 | 0.7215 | 0.5385 | 11.9659 | 77.51 | 177.52 | 94103.2 | 990.6 | 8758.1 | 3.4898 | 17887.0 | 308.86 | 5002.1 | 5362.5 | 140.49 |
| TDD039 | Group 3 | 3.5420 | 25.7523 | 0.4533 | 25.9210 | 5.9826 | 0.0000 | 3.1641 | 54.9203 | 16.6072 | 39.7193 | 7.0654 | 1.3656 | 55616.4 | 5.8196 | 0.00 | 80.38 | 0.1975 | 25.7665 | 282.74 | 0.6888 | 0.7925 | 8.4431 | 101.74 | 112.30 | 94160.4 | 1094.9 | 18860.9 | 5.4275 | 12243.7 | 699.94 | 10625.8 | 5291.2 | 175.08 |
| TDD040 | Group 3 | 4.0370 | 25.7620 | 0.4606 | 29.2705 | 5.9284 | 1.0878 | 3.2103 | 52.6916 | 17.2798 | 39.1104 | 6.6173 | 1.3532 | 55136.6 | 5.4370 | 0.00 | 79.34 | 0.1480 | 25.4901 | 248.86 | 0.7530 | 0.8334 | 7.7218 | 118.02 | 87.45 | 97932.1 | 1019.5 | 21664.7 | 5.2207 | 15609.2 | 763.79 | 12366.3 | 4711.5 | 168.89 |
| TDD041 | Group 3 | 4.4777 | 24.3255 | 0.4411 | 22.9902 | 5.9417 | 6.1135 | 2.6175 | 54.3444 | 6.9806 | 27.2166 | 5.9344 | 1.3094 | 30967.5 | 6.9970 | 0.00 | 124.70 | 0.2574 | 19.7601 | 133.76 | 0.7356 | 0.7754 | 11.1227 | 91.73 | 177.16 | 91026.4 | 529.7 | 9309.1 | 4.9302 | 17881.3 | 327.08 | 13425.4 | 4543.0 | 113.83 |
| TDD042 | Group 3 | 2.8011 | 19.2721 | 0.3844 | 21.0230 | 5.2671 | 1.0985 | 2.5795 | 39.1706 | 18.3348 | 41.0731 | 4.8294 | 1.3254 | 57166.0 | 5.3872 | 0.00 | 63.56 | 0.2514 | 24.8845 | 245.31 | 0.6902 | 0.6525 | 5.7345 | 103.90 | 148.38 | 106744.6 | 791.4 | 28165.6 | 4.4574 | 11135.8 | 863.75 | 12366.9 | 6562.1 | 173.49 |
| TDD043 | Group 3 | 3.6954 | 14.0723 | 0.2775 | 16.2142 | 3.5127 | 2.1379 | 1.7043 | 30.4922 | 16.4586 | 40.6330 | 4.0018 | 0.8206 | 53888.1 | 5.6575 | 0.00 | 72.21 | 0.1708 | 20.1560 | 95.64 | 0.6979 | 0.3883 | 7.3957 | 71.85 | 112.90 | 91147.9 | 657.4 | 11724.8 | 2.8080 | 15137.6 | 664.32 | 5752.4 | 5388.3 | 173.11 |
| TDD046 | Group 3 | 4.4741 | 30.5248 | 0.3488 | 32.1378 | 6.3707 | 1.3117 | 2.3239 | 63.9475 | 19.1527 | 96.0100 | 2.9548 | 1.5770 | 54151.3 | 7.8768 | 0.00 | 82.59 | 0.4010 | 26.4042 | 273.20 | 0.5356 | 0.7163 | 6.5521 | 96.72 | 195.08 | 94925.9 | 1419.5 | 21255.0 | 4.6174 | 12611.2 | 793.25 | 14028.3 | 4882.4 | 145.39 |
| TDD047 | Group 3 | 5.2194 | 27.1683 | 0.4182 | 27.7428 | 6.4827 | 1.5883 | 3.7034 | 65.4103 | 34.1616 | 64.6684 | 3.8547 | 1.3010 | 50294.4 | 7.9749 | 0.00 | 93.73 | 0.2009 | 20.7592 | 359.58 | 0.6216 | 0.7610 | 15.1186 | 82.17 | 221.92 | 81859.6 | 1456.9 | 21562.4 | 4.8924 | 14277.3 | 1616.08 | 8760.7 | 4300.1 | 167.13 |
| TDD048 | Group 3 | 2.4104 | 22.9867 | 0.3532 | 26.2113 | 5.6343 | 3.0103 | 2.3189 | 56.0096 | 9.5169 | 44.8116 | 3.2357 | 1.2489 | 37895.6 | 6.8478 | 0.00 | 94.56 | 0.1798 | 23.6487 | 115.55 | 0.9300 | 0.6440 | 9.2622 | 82.03 | 170.71 | 99418.9 | 426.1 | 10228.0 | 4.5688 | 18519.2 | 427.67 | 6669.7 | 5881.4 | 161.74 |
| TDD049 | Group 3 | 4.2903 | 27.8854 | 0.4784 | 29.0821 | 6.6352 | 1.3068 | 3.4033 | 54.9536 | 16.2464 | 41.9933 | 6.6052 | 1.4222 | 56321.7 | 5.2847 | 32.96 | 71.71 | 0.1243 | 25.9342 | 339.42 | 0.7191 | 0.8178 | 8.8707 | 87.37 | 142.20 | 98523.4 | 1120.8 | 19955.0 | 5.4585 | 11978.5 | 773.01 | 10802.1 | 4195.3 | 165.46 |
| TDD051 | Group 3 | 5.2743 | 30.4540 | 0.3808 | 27.6140 | 6.8987 | 2.2476 | 2.9485 | 69.8824 | 16.8915 | 40.4001 | 4.7123 | 1.5537 | 50276.0 | 5.2922 | 0.00 | 63.48 | 0.1995 | 23.6376 | 244.33 | 0.6740 | 0.9456 | 10.0462 | 83.62 | 132.78 | 106264.5 | 425.2 | 24806.6 | 4.4096 | 11419.6 | 660.73 | 13406.5 | 5507.6 | 139.81 |
| TDD054 | Group 3 | 6.2808 | 29.9552 | 0.4337 | 27.2196 | 6.1627 | 1.2308 | 3.0419 | 54.5144 | 16.8995 | 41.2285 | 5.7082 | 1.3135 | 55174.5 | 6.0116 | 0.00 | 71.12 | 0.1076 | 24.4846 | 226.42 | 0.7572 | 0.7670 | 10.0327 | 88.56 | 124.79 | 100530.2 | 1093.8 | 17893.9 | 4.9687 | 11560.3 | 778.44 | 10332.9 | 4422.3 | 171.40 |
| TDD055 | Group 3 | 3.4516 | 23.6928 | 0.3859 | 23.0877 | 5.7777 | 2.0662 | 2.8075 | 72.6694 | 35.6155 | 37.8652 | 5.2982 | 1.2011 | 53849.8 | 6.0279 | 0.00 | 87.83 | 0.1477 | 25.4606 | 173.76 | 0.6185 | 0.6606 | 9.6129 | 78.08 | 102.94 | 88824.5 | 427.1 | 11917.3 | 4.3579 | 14448.4 | 1802.32 | 10456.6 | 4201.2 | 148.95 |
| TDD058 | Group 3 | 8.0925 | 26.2030 | 0.4425 | 22.1447 | 5.4208 | 1.9283 | 3.0429 | 65.0009 | 38.1216 | 43.6137 | 4.3462 | 1.2077 | 47216.7 | 7.1239 | 41.40 | 77.32 | 0.3236 | 18.9308 | 84.38 | 0.8780 | 0.6876 | 8.8266 | 90.10 | 184.45 | 91388.1 | 788.1 | 5148.9 | 4.3194 | 10396.4 | 1766.79 | 3343.0 | 5454.5 | 137.16 |
| TDD059 | Group 3 | 4.2479 | 18.7255 | 0.3217 | 20.8239 | 4.9504 | 2.2688 | 2.1658 | 44.2215 | 19.7095 | 62.8407 | 4.7018 | 1.0747 | 50516.3 | 5.2416 | 0.00 | 90.96 | 0.2064 | 21.9942 | 145.55 | 0.6316 | 0.7459 | 7.3775 | 86.70 | 93.96 | 90085.4 | 633.4 | 17307.2 | 4.5015 | 12385.1 | 851.93 | 8260.6 | 4662.5 | 167.46 |
| TDD066 | Group 3 | 3.6739 | 23.3230 | 0.3782 | 26.4957 | 5.6177 | 1.8651 | 2.8029 | 57.4651 | 24.2926 | 64.3734 | 4.3013 | 1.2926 | 49198.4 | 9.2892 | 0.00 | 97.99 | 0.2395 | 21.9688 | 217.11 | 0.8757 | 0.7342 | 8.0082 | 79.17 | 201.53 | 82745.9 | 846.8 | 19030.8 | 5.1242 | 16144.7 | 951.32 | 8851.1 | 5279.1 | 150.67 |
| TDD067 | Group 3 | 1.8452 | 23.1530 | 0.3811 | 20.4203 | 5.8238 | 2.0940 | 2.6770 | 64.7245 | 18.8219 | 37.3226 | 3.1964 | 1.5983 | 50149.7 | 7.9764 | 0.00 | 71.97 | 0.1563 | 23.7323 | 264.28 | 0.7039 | 0.9608 | 6.8596 | 99.19 | 177.76 | 104689.1 | 764.0 | 23858.8 | 4.7084 | 11285.5 | 908.13 | 14125.4 | 4668.5 | 133.55 |
| TDD068 | Group 3 | 1.9657 | 26.5374 | 0.4484 | 28.8814 | 7.3986 | 2.1434 | 3.1288 | 57.3797 | 10.7335 | 22.3460 | 3.1170 | 2.1395 | 36835.8 | 8.9055 | 0.00 | 65.62 | 0.1407 | 19.5100 | 238.60 | 0.8636 | 1.0871 | 9.6008 | 74.08 | 223.15 | 110849.6 | 623.4 | 24035.1 | 5.8895 | 11702.4 | 317.90 | 13759.2 | 3589.6 | 92.42 |
| TDD071 | Group 3 | 3.6496 | 20.2662 | 0.3330 | 22.0515 | 4.7361 | 1.6654 | 2.0595 | 42.0650 | 20.7626 | 37.6893 | 4.2621 | 1.0777 | 45999.1 | 6.9490 | 0.00 | 80.14 | 0.2208 | 20.3961 | 100.41 | 0.8671 | 0.7305 | 10.2844 | 76.47 | 145.61 | 95634.0 | 677.2 | 10895.5 | 3.9443 | 16265.2 | 857.13 | 7523.1 | 4596.4 | 153.77 |
| TDD072 | Group 3 | 6.6524 | 31.1632 | 0.4854 | 31.4585 | 6.5896 | 1.4024 | 3.4488 | 54.5920 | 19.4906 | 43.8336 | 8.8047 | 1.5437 | 58984.8 | 5.6108 | 0.00 | 105.09 | 0.2005 | 26.0547 | 217.23 | 0.7643 | 1.1872 | 7.8419 | 108.48 | 130.39 | 95395.7 | 1221.4 | 15646.3 | 6.0639 | 16954.7 | 967.33 | 9660.5 | 4438.6 | 179.19 |
| TDD074 | Group 3 | 3.8953 | 22.8280 | 0.4408 | 24.2726 | 6.2699 | 2.7905 | 3.0860 | 52.9344 | 15.1529 | 43.2522 | 4.3548 | 1.4601 | 51591.4 | 8.5278 | 0.00 | 62.73 | 0.1544 | 24.3503 | 165.76 | 0.7952 | 0.7142 | 10.3694 | 96.18 | 205.65 | 103363.1 | 494.1 | 20009.1 | 5.0245 | 8838.2 | 757.06 | 9524.5 | 5059.8 | 147.56 |
| TDD075 | Group 3 | 4.7004 | 27.1456 | 0.4675 | 27.7726 | 6.3438 | 0.0000 | 3.1752 | 53.9612 | 17.0604 | 39.6112 | 6.9951 | 1.4614 | 54917.1 | 4.4764 | 0.00 | 86.87 | 0.1893 | 25.2149 | 270.06 | 0.6548 | 0.8308 | 8.5466 | 99.38 | 111.81 | 95022.2 | 965.2 | 16700.6 | 5.2386 | 14168.3 | 749.46 | 11421.2 | 3991.5 | 177.42 |
| TDD076 | Group 3 | 2.8728 | 24.0081 | 0.4423 | 25.7300 | 6.3121 | 1.6504 | 3.0524 | 56.5454 | 15.3814 | 45.2892 | 3.9812 | 1.4177 | 46342.0 | 9.5246 | 0.00 | 63.60 | 0.1839 | 23.4000 | 186.38 | 0.7162 | 0.8587 | 8.3455 | 84.21 | 202.60 | 95938.8 | 846.2 | 18139.3 | 5.2920 | 11586.3 | 502.08 | 9638.0 | 4786.4 | 160.29 |
| TDD077 | Group 3 | 3.7439 | 10.9571 | 0.3100 | 10.4423 | 3.8297 | 1.4417 | 1.8783 | 27.7751 | 8.8665 | 38.3248 | 4.9926 | 0.7469 | 44989.2 | 6.0626 | 0.00 | 68.95 | 0.2299 | 25.2204 | 93.55 | 0.5734 | 0.6041 | 6.6102 | 60.32 | 119.35 | 87036.6 | 254.7 | 10052.5 | 3.1708 | 13235.2 | 437.37 | 12873.8 | 4196.7 | 171.25 |
| TDD078 | Group 3 | 4.5442 | 15.7759 | 0.2967 | 17.2339 | 4.5649 | 2.1677 | 1.8575 | 40.2641 | 11.8523 | 75.1223 | 5.0365 | 0.9839 | 40599.9 | 6.0920 | 0.00 | 80.56 | 0.2309 | 22.1393 | 124.33 | 0.6119 | 0.5962 | 9.8914 | 82.13 | 111.85 | 89459.1 | 498.9 | 12999.9 | 3.6431 | 12720.5 | 383.71 | 7560.4 | 4779.8 | 139.47 |
| TDD079 | Group 3 | 11.1734 | 30.3939 | 0.4044 | 27.3423 | 6.0181 | 6.6783 | 2.0370 | 59.5648 | 13.8659 | 33.8949 | 5.1672 | 1.2777 | 46039.7 | 6.3316 | 0.00 | 114.40 | 0.8154 | 17.0723 | 162.62 | 0.7244 | 0.6364 | 9.3949 | 82.86 | 174.06 | 89297.1 | 1390.9 | 9330.1 | 3.8382 | 27908.4 | 496.19 | 8933.2 | 4706.5 | 103.96 |
| TDD080 | Group 3 | 2.1631 | 18.9649 | 0.3780 | 21.4027 | 5.1842 | 2.3771 | 2.6469 | 43.6601 | 9.4212 | 35.7904 | 3.0353 | 1.1953 | 38659.9 | 14.3210 | 0.00 | 70.85 | 0.2198 | 20.4071 | 237.00 | 0.7907 | 0.6608 | 6.9962 | 78.03 | 374.07 | 77638.2 | 990.0 | 15083.1 | 4.2190 | 12275.1 | 402.13 | 8987.9 | 5153.8 | 143.35 |
| TDD082 | Group 3 | 5.0433 | 25.7697 | 0.4397 | 27.9607 | 5.9308 | 2.3035 | 2.9125 | 61.0458 | 13.5792 | 37.2265 | 4.1590 | 1.4302 | 41868.0 | 7.5831 | 0.00 | 80.51 | 0.1895 | 20.4760 | 275.35 | 0.6065 | 0.6983 | 9.4237 | 87.47 | 190.77 | 98844.4 | 1290.3 | 22559.3 | 5.1445 | 13408.9 | 555.85 | 12445.6 | 4816.1 | 141.86 |
| TDD085 | Group 3 | 2.6329 | 51.6821 | 0.7404 | 40.0852 | 9.7799 | 3.4369 | 4.8570 | 93.1273 | 13.1599 | 46.0962 | 6.5621 | 2.4612 | 42746.0 | 7.8646 | 0.00 | 135.58 | 0.1659 | 29.2309 | 154.91 | 1.0075 | 1.6191 | 13.7641 | 117.18 | 171.57 | 107181.7 | 1050.0 | 15982.3 | 8.7423 | 16920.1 | 619.60 | 6360.5 | 6395.6 | 182.62 |
| TDD086 | Group 3 | 4.8186 | 25.5729 | 0.4652 | 23.4773 | 5.7217 | 1.3312 | 3.4861 | 51.9402 | 19.1257 | 42.3113 | 9.0031 | 1.2845 | 58444.1 | 6.4170 | 0.00 | 89.43 | 0.2162 | 25.7744 | 184.59 | 0.7910 | 0.8226 | 13.4330 | 118.95 | 149.58 | 99166.6 | 724.0 | 18278.3 | 4.7241 | 16979.5 | 725.37 | 10704.9 | 5148.4 | 158.12 |
| TDD088 | Group 3 | 0.0000 | 11.9171 | 0.2558 | 11.7268 | 3.3050 | 1.9453 | 1.5682 | 28.9168 | 11.2751 | 35.9705 | 5.7479 | 0.6240 | 43347.2 | 7.5699 | 0.00 | 79.53 | 0.2061 | 23.0117 | 123.70 | 0.5566 | 0.6303 | 6.1756 | 72.08 | 166.18 | 86714.6 | 339.6 | 10650.0 | 2.9049 | 13064.7 | 438.72 | 13171.0 | 4487.5 | 163.22 |
| TDD089 | Group 3 | 2.3248 | 25.5832 | 0.4696 | 28.0731 | 6.4625 | 0.6890 | 3.1934 | 53.4317 | 17.2545 | 44.4093 | 7.5279 | 1.3692 | 58575.2 | 4.3929 | 0.00 | 85.58 | 0.2083 | 27.0671 | 225.77 | 0.7025 | 0.8349 | 8.5518 | 95.70 | 107.73 | 98170.3 | 623.9 | 13090.8 | 5.5995 | 11927.9 | 786.22 | 14687.1 | 5603.1 | 172.12 |
| TDD090 | Group 3 | 3.8803 | 23.5032 | 0.3962 | 25.0064 | 5.0709 | 3.6327 | 2.7002 | 66.1192 | 21.0659 | 49.8978 | 4.3439 | 1.1876 | 45367.2 | 8.1848 | 31.62 | 86.58 | 0.2767 | 19.2219 | 118.94 | 0.6649 | 0.6112 | 15.9916 | 69.99 | 179.89 | 88212.1 | 648.2 | 10492.7 | 4.3463 | 17204.8 | 841.88 | 9823.8 | 5225.6 | 131.85 |
| TDD091 | Group 3 | 5.5546 | 25.1817 | 0.4514 | 19.3248 | 5.7694 | 0.0000 | 3.0080 | 49.2765 | 18.1777 | 38.7102 | 6.4805 | 1.2616 | 55369.6 | 4.4713 | 0.00 | 106.93 | 0.3081 | 27.2914 | 226.90 | 0.6895 | 0.8386 | 8.4288 | 127.02 | 114.70 | 94328.4 | 1018.6 | 14075.6 | 4.7620 | 17269.3 | 847.83 | 15315.5 | 4532.0 | 164.10 |
| TDD096 | Group 3 | 8.8968 | 28.3438 | 0.4535 | 27.4013 | 6.6707 | 1.3768 | 3.3867 | 54.8270 | 18.2922 | 44.0768 | 7.5370 | 1.4493 | 61842.7 | 4.3631 | 0.00 | 111.25 | 0.4490 | 29.4658 | 261.89 | 0.6904 | 1.2052 | 6.8704 | 116.50 | 140.82 | 99685.0 | 1243.9 | 13449.8 | 5.7405 | 17848.5 | 588.25 | 14656.2 | 4963.0 | 199.38 |
| TDD097 | Group 3 | 5.9483 | 18.3760 | 0.3489 | 20.1876 | 4.5401 | 1.4069 | 2.2457 | 59.8741 | 18.2038 | 47.1467 | 4.9977 | 1.0859 | 49434.7 | 5.3976 | 0.00 | 66.99 | 0.2820 | 21.3653 | 229.63 | 1.0923 | 0.5514 | 9.3034 | 72.41 | 121.20 | 97055.9 | 1181.3 | 17740.2 | 3.2972 | 12985.1 | 714.01 | 11171.6 | 4446.5 | 141.32 |
| TDD098 | Group 3 | 0.0000 | 35.6123 | 0.3908 | 34.4002 | 6.9306 | 1.8056 | 2.7824 | 70.8169 | 16.0686 | 63.4983 | 4.2642 | 1.6202 | 57073.6 | 6.0025 | 0.00 | 74.50 | 0.1450 | 29.2400 | 186.76 | 0.7096 | 1.0740 | 6.4241 | 107.70 | 163.50 | 107178.8 | 1651.0 | 21632.4 | 5.1569 | 11161.2 | 626.94 | 6674.3 | 6255.6 | 173.92 |
| TDD099 | Group 3 | 4.2607 | 26.7636 | 0.4775 | 31.7738 | 6.0859 | 0.9865 | 3.3462 | 52.0748 | 15.8732 | 41.4276 | 8.6087 | 1.3943 | 55345.0 | 5.7512 | 0.00 | 109.10 | 0.1906 | 25.1223 | 228.44 | 0.7174 | 0.8137 | 10.6694 | 106.74 | 93.65 | 96815.0 | 1275.9 | 18399.4 | 6.0471 | 13783.3 | 711.02 | 11562.8 | 5281.7 | 160.63 |
| TDD101 | Group 3 | 2.6628 | 27.4943 | 0.4966 | 27.0299 | 6.8695 | 2.0699 | 3.4504 | 55.9321 | 18.8483 | 38.5565 | 6.7682 | 1.5066 | 53929.0 | 5.9076 | 0.00 | 91.23 | 0.1478 | 27.5829 | 161.00 | 0.7016 | 0.9836 | 11.4088 | 90.48 | 124.85 | 94373.4 | 445.0 | 17414.1 | 6.4007 | 17005.6 | 1195.10 | 10875.9 | 5166.3 | 169.83 |
| TDD103 | Group 3 | 0.0000 | 23.4365 | 0.4076 | 21.9693 | 6.4208 | 1.1352 | 3.2193 | 49.6459 | 21.5074 | 75.9132 | 2.7324 | 1.5092 | 58177.4 | 4.9409 | 0.00 | 46.50 | 0.1290 | 29.5583 | 219.73 | 0.7981 | 1.0687 | 4.1947 | 93.37 | 127.68 | 91073.0 | 448.8 | 30489.9 | 5.9982 | 7027.1 | 1277.72 | 10947.0 | 5935.2 | 178.02 |
| TDD110 | Group 3 | 4.8061 | 27.0322 | 0.2978 | 28.1534 | 5.8877 | 0.8853 | 2.2196 | 67.1711 | 16.8265 | 78.3523 | 2.9462 | 1.5040 | 50377.4 | 6.9250 | 0.00 | 69.30 | 0.3558 | 25.7796 | 254.54 | 0.4764 | 0.8063 | 5.8680 | 87.53 | 204.68 | 97089.1 | 1135.7 | 20077.0 | 4.8418 | 9525.9 | 819.43 | 14099.0 | 5215.5 | 149.86 |
| TDD111 | Group 3 | 4.3830 | 19.2915 | 0.3204 | 19.9982 | 5.0090 | 1.4726 | 2.4345 | 40.3466 | 21.4279 | 74.6875 | 4.8878 | 1.0802 | 51919.8 | 5.4101 | 0.00 | 91.19 | 0.2157 | 23.2116 | 202.73 | 0.6606 | 0.6550 | 7.2744 | 84.52 | 95.42 | 90404.4 | 658.6 | 15993.8 | 4.4248 | 14902.8 | 983.81 | 7680.5 | 4940.9 | 160.59 |
| TDD112 | Group 3 | 4.5105 | 21.3438 | 0.3159 | 22.4956 | 5.3614 | 1.6068 | 2.3981 | 36.7388 | 16.7579 | 64.0037 | 4.2605 | 1.1131 | 48153.5 | 4.9952 | 0.00 | 88.15 | 0.1646 | 20.8765 | 129.80 | 0.5864 | 0.6894 | 6.7664 | 69.46 | 99.27 | 90135.9 | 728.7 | 19708.4 | 4.6023 | 12709.7 | 632.33 | 8906.6 | 4718.5 | 159.71 |
| TDD113 | Group 3 | 5.4120 | 25.0266 | 0.3905 | 25.5420 | 6.1481 | 0.8167 | 3.2649 | 53.6000 | 18.1854 | 41.6558 | 5.0039 | 1.3906 | 56497.9 | 6.0198 | 0.00 | 88.21 | 0.2750 | 26.5200 | 275.24 | 0.6803 | 0.8395 | 6.3586 | 101.80 | 96.88 | 97518.7 | 1171.4 | 14189.8 | 5.7320 | 15492.4 | 781.76 | 13826.1 | 5099.8 | 189.59 |
| TDD115 | Group 3 | 4.1277 | 11.5975 | 0.2676 | 13.3831 | 3.4447 | 1.4249 | 1.7864 | 29.6272 | 11.0071 | 36.1539 | 5.5673 | 0.6570 | 41979.8 | 9.4728 | 0.00 | 77.72 | 0.1881 | 23.0170 | 110.97 | 0.5198 | 0.4831 | 7.5919 | 65.76 | 218.72 | 87536.9 | 370.5 | 10918.5 | 3.3683 | 13008.4 | 412.50 | 12520.9 | 4665.6 | 167.17 |
| TDD116 | Group 3 | 4.1275 | 24.9048 | 0.5126 | 28.2803 | 6.6963 | 2.4849 | 3.7676 | 54.6771 | 14.9694 | 77.7907 | 3.7954 | 1.5872 | 34819.5 | 10.6712 | 0.00 | 66.23 | 0.2336 | 23.3791 | 92.79 | 0.7136 | 1.1035 | 7.6062 | 83.01 | 285.92 | 90012.1 | 503.3 | 6570.0 | 7.1268 | 11014.6 | 232.41 | 7707.2 | 5939.8 | 172.68 |
| TDD117 | Group 3 | 4.9280 | 13.6314 | 0.2966 | 14.6607 | 3.9924 | 2.0957 | 2.2509 | 32.8549 | 11.0287 | 38.2531 | 4.5968 | 0.8189 | 41292.1 | 8.0239 | 0.00 | 70.42 | 0.1935 | 20.4640 | 128.56 | 0.5729 | 0.5370 | 23.4083 | 58.07 | 200.30 | 82876.7 | 289.9 | 9489.3 | 3.3472 | 10708.3 | 443.28 | 10114.7 | 4206.2 | 178.14 |
| TDD118 | Group 3 | 4.9936 | 27.0391 | 0.4070 | 32.5017 | 6.9023 | 1.8436 | 2.9140 | 48.6637 | 15.9796 | 21.5741 | 5.8377 | 1.4911 | 52378.5 | 4.0524 | 0.00 | 93.17 | 0.3140 | 22.3032 | 209.13 | 0.7845 | 0.7795 | 4.9278 | 95.18 | 90.09 | 96398.8 | 902.0 | 26484.0 | 5.2717 | 12531.0 | 659.89 | 12883.8 | 5533.5 | 166.12 |
| TDD120 | Group 3 | 6.1617 | 26.8806 | 0.4129 | 36.9089 | 7.6297 | 1.2985 | 3.2236 | 50.7712 | 18.3349 | 30.3822 | 2.6243 | 1.7227 | 63597.5 | 6.9187 | 0.00 | 41.62 | 0.2445 | 28.9457 | 188.31 | 0.8444 | 0.9621 | 5.5550 | 83.96 | 164.17 | 93954.3 | 972.0 | 18526.0 | 5.9810 | 5789.5 | 1015.43 | 8938.5 | 9388.9 | 201.77 |
| TDD123 | Group 3 | 5.5195 | 28.1256 | 0.3926 | 25.0661 | 5.8062 | 1.3115 | 2.8065 | 54.7503 | 16.3273 | 38.1995 | 6.3910 | 1.2283 | 53386.6 | 5.1281 | 0.00 | 110.25 | 0.2489 | 25.4207 | 605.48 | 0.7000 | 1.0406 | 6.9658 | 99.26 | 103.05 | 92682.3 | 929.0 | 11910.4 | 4.4183 | 16794.2 | 721.79 | 15216.2 | 4368.7 | 168.77 |
| TDD124 | Group 3 | 2.6204 | 32.2964 | 0.4487 | 33.7765 | 7.0714 | 1.5207 | 3.2919 | 94.4643 | 16.6034 | 36.0411 | 3.0171 | 1.6275 | 42531.0 | 6.8569 | 0.00 | 72.10 | 0.1109 | 21.1546 | 187.69 | 0.6190 | 0.9393 | 5.4822 | 78.36 | 160.70 | 92281.3 | 838.1 | 16939.6 | 5.6524 | 16101.7 | 397.22 | 10166.9 | 4711.4 | 136.06 |
| TDD126 | Group 3 | 3.1427 | 20.8806 | 0.4521 | 24.7018 | 6.3241 | 1.9250 | 3.2542 | 58.2412 | 16.3421 | 40.5221 | 3.8079 | 1.4944 | 44913.0 | 6.6239 | 0.00 | 86.97 | 0.1695 | 22.8756 | 170.96 | 0.8137 | 1.1435 | 7.8499 | 63.00 | 160.99 | 87919.5 | 427.3 | 18316.0 | 5.1867 | 15769.2 | 762.32 | 10292.6 | 3978.8 | 144.04 |
| TDD127 | Group 3 | 9.3371 | 28.1196 | 0.4581 | 29.9725 | 6.5320 | 2.1861 | 3.6973 | 52.6827 | 15.3412 | 37.8506 | 5.6731 | 1.3783 | 53346.1 | 5.2710 | 0.00 | 99.30 | 0.2881 | 25.9411 | 258.58 | 0.7354 | 0.8191 | 11.0949 | 96.26 | 129.38 | 96363.2 | 1361.7 | 10536.2 | 5.5593 | 18232.7 | 674.99 | 15154.1 | 5886.8 | 150.04 |
| TDD131 | Group 3 | 6.7680 | 19.6912 | 0.4510 | 19.6038 | 4.8854 | 2.4188 | 3.1702 | 60.4188 | 31.0987 | 45.2220 | 3.8001 | 1.0525 | 46674.4 | 9.0449 | 0.00 | 69.00 | 0.2807 | 17.7361 | 87.45 | 0.8724 | 0.6237 | 7.5441 | 61.86 | 196.05 | 85057.7 | 799.6 | 3405.8 | 4.3164 | 11353.5 | 1077.63 | 3759.9 | 4820.1 | 132.73 |
| TDD132 | Group 3 | 6.8656 | 29.5340 | 0.4932 | 36.9264 | 8.2245 | 1.4206 | 3.7665 | 46.8875 | 13.7596 | 29.8561 | 2.9819 | 1.7855 | 66235.1 | 7.5270 | 0.00 | 33.79 | 0.2157 | 30.3687 | 206.33 | 0.7744 | 0.9955 | 6.2817 | 83.80 | 163.37 | 95889.6 | 541.8 | 17834.4 | 5.8826 | 5928.6 | 685.63 | 8972.0 | 8525.3 | 196.59 |
| TDD134 | Group 3 | 3.6002 | 32.3209 | 0.5288 | 32.2748 | 7.1334 | 2.7188 | 3.9947 | 60.9366 | 14.6561 | 42.3476 | 4.5575 | 1.6611 | 37131.6 | 6.2554 | 0.00 | 75.32 | 0.2047 | 23.9298 | 187.57 | 0.7064 | 1.0262 | 7.6460 | 77.94 | 141.15 | 94923.5 | 443.2 | 21239.9 | 6.6559 | 14212.8 | 474.37 | 14205.7 | 4662.6 | 144.49 |
| TDD136 | Group 3 | 4.4522 | 21.9813 | 0.4277 | 25.1630 | 6.1845 | 2.9611 | 3.0678 | 83.1845 | 27.6833 | 35.3226 | 4.5502 | 1.3220 | 42764.5 | 7.9012 | 0.00 | 70.69 | 0.2540 | 21.0167 | 109.76 | 0.8319 | 1.1312 | 7.7099 | 56.72 | 175.48 | 78904.8 | 545.4 | 10318.9 | 4.4242 | 12565.0 | 1052.12 | 7876.5 | 3906.0 | 133.70 |
| TDD137 | Group 3 | 5.9503 | 11.4651 | 0.2506 | 12.6879 | 3.1942 | 2.7185 | 1.9804 | 23.7746 | 12.4605 | 43.5242 | 4.1726 | 0.7107 | 46487.4 | 7.8467 | 0.00 | 82.19 | 0.1918 | 18.8075 | 91.46 | 0.8691 | 0.3953 | 8.0169 | 68.70 | 196.30 | 88165.5 | 456.7 | 8630.0 | 2.8708 | 13507.9 | 348.68 | 6732.6 | 4495.8 | 148.94 |
| TDD138 | Group 3 | 0.0000 | 22.3118 | 0.4199 | 26.5853 | 6.6172 | 1.1578 | 3.1265 | 45.0734 | 18.5471 | 77.4216 | 3.1752 | 1.5267 | 57628.4 | 4.6691 | 0.00 | 62.99 | 0.1822 | 30.5395 | 201.30 | 0.8220 | 0.9485 | 4.5372 | 91.67 | 138.66 | 94554.2 | 236.7 | 33187.8 | 4.7048 | 6737.0 | 1011.29 | 12999.3 | 5498.4 | 190.29 |
| TDD139 | Group 3 | 0.0000 | 34.4324 | 0.4909 | 36.6831 | 8.5341 | 2.4020 | 3.8093 | 74.2004 | 9.9516 | 48.2349 | 3.9603 | 1.8446 | 35913.4 | 9.4504 | 0.00 | 84.46 | 0.2571 | 26.9399 | 120.43 | 0.9008 | 1.6449 | 10.1955 | 77.25 | 227.97 | 95526.4 | 365.9 | 19624.1 | 7.3511 | 12956.2 | 456.02 | 10222.3 | 5460.7 | 163.15 |

| anid | Chemical Group | As | La | Lu | Nd | Sm | U | Yb | Ce | Co | Cr | Cs | Eu | Fe | Hf | Ni | Rb | Sb | Sc | Sr | Ta | Tb | Th | Zn | Zr | Al | Ba | Ca | Dy | K | Mn | Na | Ti | V |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TDD141 | Group 3 | 4.6150 | 22.5768 | 0.4264 | 26.6527 | 6.3018 | 3.3750 | 2.8715 | 56.0510 | 12.3746 | 44.8392 | 3.9867 | 1.3470 | 39792.1 | 8.5090 | 0.00 | 82.14 | 0.1834 | 22.8586 | 142.72 | 0.7607 | 0.9626 | 9.0245 | 64.78 | 239.23 | 84197.4 | 377.2 | 16352.0 | 4.5102 | 11898.9 | 494.30 | 9680.3 | 5342.5 | 142.05 |
| TDD142 | Group 3 | 3.9189 | 22.1805 | 0.4072 | 25.6687 | 6.0163 | 2.9542 | 2.7714 | 48.4561 | 13.1921 | 39.3556 | 4.0894 | 1.3785 | 42809.8 | 6.3285 | 0.00 | 59.62 | 0.2645 | 21.2149 | 176.34 | 0.9758 | 0.7846 | 8.7856 | 63.55 | 134.24 | 95164.0 | 463.0 | 19860.3 | 4.3220 | 10873.1 | 481.67 | 11122.7 | 4459.8 | 141.10 |
| TDD144 | Group 3 | 3.7572 | 19.7472 | 0.3252 | 21.6183 | 5.0394 | 1.9742 | 2.2051 | 47.5511 | 15.4535 | 42.6162 | 4.3072 | 1.0360 | 43363.9 | 6.7971 | 0.00 | 71.56 | 0.1719 | 20.3261 | 162.74 | 0.6971 | 0.6243 | 9.5814 | 74.00 | 144.65 | 92286.7 | 443.6 | 21663.8 | 4.1036 | 10626.0 | 555.80 | 11696.8 | 5165.9 | 155.85 |
| TDD149 | Group 3 | 3.9142 | 21.3350 | 0.3725 | 26.1210 | 5.8367 | 2.4825 | 2.8274 | 39.3852 | 16.3812 | 61.3963 | 3.9124 | 1.2298 | 45013.8 | 7.7744 | 0.00 | 89.92 | 0.2803 | 21.6236 | 250.65 | 0.5617 | 0.7705 | 24.4593 | 88.44 | 162.33 | 78892.1 | 1423.1 | 19845.6 | 5.1250 | 16472.0 | 781.93 | 9446.6 | 4846.8 | 151.01 |
| TDD153 | Group 3 | 3.5166 | 27.0554 | 0.4805 | 32.6331 | 7.0318 | 2.0296 | 3.5250 | 55.5009 | 18.9151 | 40.3944 | 3.7642 | 1.6084 | 48399.7 | 7.6588 | 19.85 | 74.75 | 0.1334 | 21.9198 | 245.15 | 0.6787 | 1.3116 | 7.5760 | 74.66 | 197.13 | 93236.3 | 1303.5 | 20180.6 | 6.1065 | 14696.2 | 639.95 | 10260.0 | 3989.8 | 132.20 |
| TDD154 | Group 3 | 3.5986 | 22.0314 | 0.3579 | 22.3490 | 5.2384 | 1.9104 | 2.7390 | 56.5434 | 12.2716 | 40.3887 | 3.9995 | 1.1485 | 46791.0 | 5.9205 | 0.00 | 104.86 | 0.2540 | 19.4883 | 90.68 | 0.7214 | 0.7136 | 9.8287 | 80.74 | 149.59 | 97547.1 | 475.1 | 9970.1 | 4.1374 | 17622.3 | 238.90 | 9231.8 | 4624.3 | 139.53 |
| TDD155 | Group 3 | 4.7566 | 30.0383 | 0.3437 | 26.8853 | 6.0760 | 2.6711 | 2.6077 | 69.5173 | 17.7835 | 34.7959 | 4.0292 | 1.3013 | 40982.9 | 7.7117 | 43.18 | 101.55 | 0.2775 | 17.4557 | 200.49 | 0.7560 | 1.0109 | 8.6271 | 81.31 | 222.53 | 90957.6 | 1086.0 | 6624.0 | 5.1212 | 14953.0 | 709.74 | 5794.6 | 4588.3 | 111.01 |
| TDD156 | Group 3 | 4.0531 | 19.5731 | 0.3435 | 23.5733 | 5.0758 | 2.2576 | 2.5478 | 48.1546 | 15.9866 | 44.8697 | 5.2678 | 1.1943 | 51585.6 | 6.8794 | 0.00 | 95.45 | 0.1493 | 22.6416 | 173.47 | 0.7358 | 0.6959 | 9.4107 | 86.84 | 167.80 | 104031.1 | 479.1 | 16642.4 | 4.0562 | 8097.3 | 503.00 | 8709.3 | 5039.2 | 165.32 |
| TDD157 | Group 3 | 5.0314 | 29.2319 | 0.4139 | 26.4523 | 6.3456 | 1.2171 | 3.1845 | 62.0638 | 18.0922 | 42.7021 | 6.7354 | 1.3672 | 56335.2 | 5.2221 | 0.00 | 82.04 | 0.1871 | 26.1815 | 211.95 | 0.7409 | 0.9082 | 8.5575 | 86.48 | 127.43 | 93600.3 | 1099.0 | 18347.2 | 5.2040 | 11873.8 | 709.64 | 11380.1 | 4925.4 | 156.76 |
| TDD158 | Group 3 | 4.3034 | 23.3698 | 0.3722 | 23.4406 | 5.9457 | 3.0973 | 2.7493 | 60.1565 | 16.0466 | 43.8245 | 4.6473 | 1.4416 | 51557.3 | 6.0853 | 0.00 | 65.57 | 0.1870 | 23.0667 | 221.35 | 0.8438 | 0.8000 | 10.0330 | 75.19 | 124.21 | 110787.9 | 572.1 | 24201.7 | 4.7231 | 10217.5 | 636.36 | 11836.3 | 4939.3 | 175.65 |
| TDD159 | Group 3 | 2.0808 | 30.6643 | 0.5094 | 33.0925 | 8.0593 | 3.4453 | 3.7870 | 62.0924 | 10.7425 | 39.0365 | 4.3867 | 1.8671 | 48855.5 | 10.1019 | 0.00 | 116.00 | 0.1717 | 27.6495 | 170.86 | 0.6581 | 1.1247 | 10.3100 | 87.56 | 304.36 | 106218.4 | 1051.3 | 10235.1 | 6.6882 | 17855.4 | 668.62 | 7824.7 | 7447.6 | 203.54 |
| TDD164 | Group 3 | 3.9343 | 16.0403 | 0.3505 | 19.0249 | 4.6820 | 0.8732 | 2.5687 | 46.8858 | 16.9519 | 34.4154 | 5.3543 | 0.9731 | 44838.6 | 8.0907 | 0.00 | 84.99 | 0.1513 | 22.7836 | 183.14 | 0.6441 | 0.6413 | 11.0954 | 60.27 | 210.14 | 84901.0 | 279.9 | 17264.6 | 4.1581 | 10925.6 | 824.67 | 13559.9 | 3939.0 | 118.36 |
| TDD166 | Group 3 | 5.6074 | 26.4805 | 0.4140 | 29.7441 | 6.2636 | 1.0149 | 3.2133 | 53.9447 | 17.9060 | 42.4098 | 8.1367 | 1.4070 | 57225.7 | 4.7245 | 0.00 | 82.49 | 0.1691 | 25.9169 | 230.32 | 0.7125 | 0.8525 | 7.6600 | 92.12 | 139.02 | 97102.2 | 689.3 | 18492.9 | 5.2995 | 14511.2 | 820.08 | 10786.1 | 5686.0 | 170.01 |
| TDD185 | Group 3 | 3.0279 | 30.5969 | 0.4069 | 33.4189 | 6.3503 | 2.4935 | 2.9722 | 52.1503 | 12.2053 | 39.2635 | 7.9766 | 1.4877 | 49122.1 | 6.1751 | 0.00 | 86.09 | 0.3376 | 19.3726 | 186.19 | 0.5554 | 0.8649 | 7.9945 | 91.67 | 164.57 | 95932.3 | 377.9 | 15641.1 | 5.0835 | 13059.8 | 691.03 | 15388.7 | 5472.4 | 140.52 |
| TDD233 | Group 3 | 6.4180 | 42.4236 | 0.5782 | 45.3945 | 8.7480 | 3.5180 | 3.8096 | 89.3289 | 22.0253 | 56.9988 | 8.0209 | 1.8739 | 59926.4 | 9.4789 | 0.00 | 151.61 | 0.2532 | 25.4464 | 143.16 | 1.1072 | 1.1285 | 13.1094 | 130.69 | 217.02 | 111466.9 | 441.8 | 16327.3 | 6.3188 | 18967.0 | 1221.37 | 9361.6 | 6227.3 | 176.59 |
| TDD238 | Group 3 | 9.3052 | 41.0304 | 0.6308 | 34.6494 | 8.5977 | 3.1854 | 4.4594 | 77.0840 | 14.9475 | 57.1688 | 6.5368 | 1.8025 | 36213.8 | 8.5702 | 0.00 | 115.09 | 0.4026 | 20.1622 | 0.00 | 1.0643 | 1.2116 | 10.8354 | 84.41 | 211.65 | 89582.9 | 471.1 | 3278.3 | 6.6215 | 12713.5 | 993.47 | 4721.1 | 5653.9 | 136.96 |
| TDD242 | Group 3 | 4.6504 | 27.2390 | 0.4290 | 27.5496 | 5.5329 | 3.0947 | 3.0741 | 50.5326 | 12.9950 | 54.0640 | 6.7039 | 1.1149 | 41405.9 | 10.5291 | 0.00 | 127.71 | 0.2290 | 21.6607 | 98.22 | 1.0166 | 0.9103 | 11.4608 | 86.65 | 231.52 | 107193.5 | 352.3 | 12340.6 | 4.1832 | 18082.0 | 817.24 | 9590.3 | 5564.7 | 149.72 |
| TDD262 | Group 3 | 3.4291 | 22.6999 | 0.3594 | 26.6976 | 5.4023 | 2.4958 | 2.4671 | 56.2549 | 16.5749 | 39.8644 | 4.3799 | 1.1837 | 45082.5 | 8.1510 | 0.00 | 93.07 | 0.2175 | 18.7212 | 150.55 | 0.8339 | 1.0699 | 8.3714 | 74.19 | 180.48 | 87657.8 | 526.9 | 15604.3 | 3.7869 | 16502.7 | 800.65 | 11309.3 | 4112.7 | 129.34 |
| TDD263 | Group 3 | 0.0000 | 16.4332 | 0.2964 | 16.8010 | 4.0032 | 2.2216 | 1.8954 | 38.0393 | 11.1649 | 45.7010 | 3.8789 | 0.8669 | 39686.1 | 6.9495 | 0.00 | 127.29 | 0.2263 | 23.3105 | 69.33 | 0.8004 | 0.4925 | 6.1443 | 86.52 | 146.45 | 108403.1 | 443.4 | 9096.4 | 3.5500 | 20356.6 | 354.38 | 5746.1 | 6200.3 | 184.69 |
| TDD264 | Group 3 | 3.1673 | 21.9957 | 0.3237 | 22.8422 | 5.0836 | 3.3144 | 2.7933 | 54.8241 | 16.1191 | 44.5402 | 5.5748 | 1.1630 | 47811.0 | 5.1379 | 0.00 | 102.01 | 0.2511 | 21.5975 | 181.87 | 0.6597 | 0.6382 | 11.0022 | 105.68 | 133.05 | 99235.4 | 585.7 | 9831.0 | 3.7580 | 15124.2 | 490.57 | 16016.1 | 4603.4 | 122.89 |
| TDD265 | Group 3 | 3.8746 | 24.6465 | 0.4590 | 34.9613 | 6.4105 | 2.0035 | 3.4284 | 63.7620 | 18.9841 | 42.0563 | 4.0196 | 1.5118 | 48216.1 | 9.6067 | 0.00 | 47.70 | 0.2487 | 24.0002 | 190.91 | 0.8193 | 1.1484 | 9.5230 | 77.38 | 227.81 | 99722.4 | 435.4 | 17389.7 | 5.0838 | 8858.9 | 769.86 | 9295.7 | 4870.0 | 168.21 |
| TDD279 | Group 3 | 2.8243 | 25.9904 | 0.3987 | 29.7114 | 6.1267 | 1.6569 | 2.9123 | 56.9937 | 18.4964 | 51.1933 | 5.9714 | 1.3292 | 51587.7 | 5.9485 | 0.00 | 127.21 | 0.1574 | 23.6142 | 238.47 | 0.7180 | 0.7692 | 6.6756 | 95.93 | 122.98 | 98538.6 | 813.6 | 10945.1 | 5.0186 | 16318.8 | 333.49 | 7297.2 | 5233.7 | 134.97 |
| TDD287 | Group 3 | 3.1304 | 24.4688 | 0.4482 | 26.8160 | 5.9809 | 1.2397 | 3.1084 | 52.0949 | 15.3631 | 38.6520 | 6.0107 | 1.2642 | 42368.9 | 4.9487 | 0.00 | 99.15 | 0.1883 | 20.5340 | 193.36 | 0.6244 | 0.8176 | 7.1123 | 83.64 | 110.73 | 90801.4 | 588.3 | 20980.9 | 5.3981 | 14709.3 | 628.21 | 14365.4 | 4178.0 | 142.38 |
| TDD289 | Group 3 | 2.0887 | 26.0721 | 0.4516 | 33.6441 | 6.9020 | 1.5773 | 3.4576 | 53.8995 | 13.0412 | 48.1024 | 4.2143 | 1.5918 | 41384.4 | 9.5384 | 0.00 | 79.21 | 0.2133 | 27.3504 | 188.42 | 0.7202 | 0.9826 | 7.5521 | 95.55 | 198.46 | 101907.4 | 588.4 | 30672.4 | 5.6802 | 15629.7 | 660.60 | 14771.6 | 6238.9 | 172.97 |
| TDD293 | Group 3 | 6.5071 | 19.6741 | 0.3530 | 29.7044 | 5.2774 | 2.1775 | 2.5002 | 47.8795 | 17.6069 | 76.7336 | 3.5276 | 1.1012 | 55278.7 | 8.9116 | 30.53 | 78.93 | 0.2533 | 23.7518 | 134.24 | 0.7263 | 0.6652 | 8.7147 | 80.16 | 203.17 | 90909.1 | 457.7 | 16710.6 | 4.2784 | 14276.9 | 624.67 | 8221.9 | 5992.1 | 186.25 |
| TDD300 | Group 3 | 2.7507 | 19.8311 | 0.3735 | 25.8829 | 5.6170 | 0.9703 | 2.7308 | 43.9550 | 20.8099 | 74.8113 | 3.3949 | 1.2408 | 55068.8 | 5.3369 | 0.00 | 47.66 | 0.1589 | 27.0820 | 231.68 | 0.6770 | 0.6804 | 11.0042 | 93.37 | 116.34 | 95737.3 | 222.8 | 40373.4 | 4.6485 | 8256.3 | 1180.60 | 13792.3 | 5595.4 | 202.65 |
| TDD301 | Group 3 | 4.4692 | 25.9986 | 0.4307 | 30.4595 | 6.4757 | 2.4157 | 3.1568 | 45.5783 | 11.8510 | 39.0964 | 4.2282 | 1.4021 | 43265.2 | 7.8423 | 0.00 | 89.11 | 0.1997 | 22.4389 | 234.25 | 0.6296 | 1.1368 | 9.0525 | 73.07 | 181.38 | 88859.7 | 579.3 | 23300.0 | 5.5584 | 14280.4 | 843.90 | 12720.6 | 4479.7 | 144.31 |
| TDD303 | Group 3 | 4.8469 | 23.6467 | 0.3441 | 25.8840 | 5.9801 | 2.4005 | 2.9954 | 49.9231 | 16.1860 | 53.3453 | 5.3910 | 1.4031 | 48459.0 | 7.0607 | 0.00 | 98.54 | 0.2116 | 22.9888 | 223.18 | 0.7184 | 0.7253 | 9.4520 | 70.43 | 160.71 | 90069.8 | 409.7 | 20885.3 | 4.9591 | 12726.3 | 856.22 | 13513.8 | 4997.5 | 141.60 |
| TDD310 | Group 3 | 3.3184 | 15.4785 | 0.2750 | 19.0876 | 4.2800 | 1.9212 | 2.2240 | 47.8248 | 17.8072 | 38.3047 | 2.8342 | 0.9446 | 48483.4 | 6.3705 | 0.00 | 78.78 | 0.2680 | 20.2516 | 109.24 | 0.8776 | 0.5162 | 9.3363 | 59.92 | 146.98 | 94139.5 | 390.8 | 9405.1 | 3.1460 | 10812.2 | 795.48 | 9286.5 | 4757.2 | 128.19 |
| TDD312 | Group 3 | 2.7542 | 12.3019 | 0.2976 | 14.3700 | 3.9685 | 1.5728 | 2.0885 | 33.3727 | 11.3717 | 39.5765 | 4.7560 | 0.8449 | 45938.2 | 8.9403 | 0.00 | 82.79 | 0.2194 | 21.2040 | 116.61 | 0.6407 | 0.5449 | 7.6996 | 64.66 | 227.20 | 85651.9 | 420.5 | 15984.4 | 3.3348 | 14568.8 | 569.16 | 9324.2 | 4754.5 | 137.84 |
| TDD314 | Group 3 | 7.5326 | 30.8029 | 0.4698 | 30.6993 | 6.6746 | 2.5991 | 3.2474 | 63.0632 | 22.3363 | 59.0610 | 5.8369 | 1.3905 | 59200.6 | 11.4175 | 0.00 | 99.05 | 0.3983 | 23.3630 | 75.55 | 0.9633 | 0.8881 | 11.1957 | 93.94 | 275.19 | 102587.2 | 442.1 | 10532.0 | 5.0747 | 16737.2 | 813.18 | 10329.0 | 5847.9 | 150.41 |
| TDD315 | Group 3 | 9.3998 | 21.3833 | 0.3158 | 20.3812 | 5.3165 | 1.7752 | 2.3694 | 52.7614 | 15.5216 | 44.0616 | 4.4328 | 1.1833 | 47239.3 | 4.9941 | 0.00 | 76.07 | 0.2486 | 20.7681 | 159.77 | 1.0766 | 0.6384 | 8.9468 | 64.22 | 126.98 | 92380.9 | 782.2 | 15738.2 | 4.0618 | 11562.1 | 639.44 | 9269.6 | 4916.0 | 150.49 |
| TDD317 | Group 3 | 12.4709 | 18.3601 | 0.3662 | 20.4188 | 4.8634 | 1.0066 | 2.7563 | 41.7039 | 16.2787 | 38.8951 | 8.4959 | 1.1312 | 55024.2 | 5.4143 | 0.00 | 99.11 | 0.2118 | 23.5589 | 160.15 | 0.7491 | 0.7433 | 7.5004 | 72.02 | 113.91 | 100893.6 | 453.0 | 16291.9 | 4.2905 | 14160.8 | 569.96 | 12116.9 | 4888.5 | 167.82 |
| TDD318 | Group 3 | 12.2919 | 20.8527 | 0.3730 | 19.4599 | 5.1862 | 0.9726 | 2.7241 | 46.3968 | 16.9770 | 41.2342 | 8.5584 | 1.1386 | 57631.6 | 4.7282 | 0.00 | 97.78 | 0.2094 | 24.6521 | 129.25 | 0.7464 | 0.7897 | 12.3375 | 70.98 | 127.49 | 98402.3 | 372.3 | 15766.2 | 4.4037 | 12280.3 | 591.80 | 10753.0 | 5087.9 | 179.00 |
| TDD319 | Group 3 | 4.7459 | 23.4776 | 0.3979 | 21.0681 | 5.5209 | 0.6140 | 2.8864 | 51.7595 | 15.5395 | 35.4744 | 7.1058 | 1.2077 | 44920.0 | 5.0763 | 0.00 | 102.83 | 0.1505 | 23.1681 | 145.70 | 0.5774 | 1.0576 | 10.5951 | 75.52 | 124.46 | 93800.2 | 476.9 | 16805.4 | 4.6423 | 14403.3 | 763.50 | 14322.9 | 3678.2 | 143.65 |
| TDD320 | Group 3 | 6.3750 | 22.8213 | 0.3759 | 18.4350 | 5.3910 | 0.8498 | 2.8965 | 53.6224 | 16.2881 | 33.7096 | 7.1967 | 1.2560 | 44758.4 | 5.3906 | 0.00 | 105.08 | 0.2376 | 23.1770 | 179.58 | 0.6264 | 0.7841 | 6.1774 | 77.49 | 128.21 | 83826.2 | 391.6 | 17094.6 | 4.9413 | 14906.2 | 738.80 | 14542.8 | 3505.9 | 151.38 |
| TDD321 | Group 3 | 1.9649 | 35.3690 | 0.4747 | 32.4476 | 7.6878 | 3.2563 | 3.5848 | 73.7830 | 16.5280 | 39.7654 | 5.4656 | 1.8432 | 47112.8 | 11.8604 | 0.00 | 98.36 | 0.2958 | 22.0936 | 83.91 | 0.9467 | 1.0556 | 11.5192 | 72.72 | 319.49 | 93981.0 | 461.0 | 7490.7 | 5.7152 | 14746.4 | 811.87 | 5663.2 | 6904.0 | 153.24 |
| TDD326 | Group 3 | 4.7472 | 40.6006 | 0.5035 | 37.6815 | 7.9701 | 2.5961 | 3.6189 | 80.9576 | 16.8819 | 51.3356 | 8.1109 | 1.8371 | 50590.0 | 6.9401 | 43.04 | 134.64 | 0.2349 | 25.4378 | 93.17 | 1.0954 | 1.3778 | 11.6308 | 104.76 | 174.15 | 113497.0 | 555.1 | 13170.9 | 6.5055 | 16341.1 | 994.57 | 8128.6 | 6068.8 | 165.94 |
| TDD333 | Group 3 | 0.0000 | 23.7711 | 0.4214 | 22.6756 | 5.2456 | 1.6458 | 2.8397 | 52.1025 | 11.2541 | 27.4759 | 6.2652 | 1.1448 | 25437.3 | 7.4536 | 0.00 | 91.06 | 0.2128 | 16.9960 | 36.99 | 0.6178 | 0.7554 | 10.0898 | 68.33 | 154.58 | 81944.7 | 524.0 | 4627.1 | 4.9070 | 15853.3 | 184.17 | 5232.1 | 4530.6 | 109.34 |
| TDD337 | Group 3 | 2.6166 | 27.5544 | 0.3888 | 27.0307 | 6.2511 | 2.6074 | 2.6093 | 64.8316 | 15.2642 | 43.6513 | 5.6883 | 1.4251 | 49545.7 | 5.7581 | 0.00 | 79.98 | 0.1538 | 21.9541 | 182.65 | 0.7556 | 0.7885 | 10.2974 | 92.29 | 121.86 | 107423.5 | 364.9 | 21760.9 | 4.2217 | 12974.5 | 700.51 | 10463.8 | 4248.2 | 157.94 |
| TDD338 | Group 3 | 1.9485 | 29.5079 | 0.4055 | 32.2989 | 7.0970 | 2.7354 | 2.8992 | 57.5697 | 15.0592 | 48.4831 | 5.8453 | 1.5272 | 50719.3 | 6.4521 | 0.00 | 83.27 | 0.1639 | 23.5249 | 143.81 | 0.8518 | 0.8482 | 10.7209 | 78.72 | 164.00 | 98529.7 | 467.5 | 20193.8 | 5.3340 | 12988.5 | 472.97 | 10437.6 | 4690.7 | 151.91 |
| TDD340 | Group 3 | 2.8647 | 28.9036 | 0.4847 | 30.7506 | 7.1180 | 3.9186 | 3.2624 | 59.8289 | 18.8982 | 58.0565 | 5.8033 | 1.4834 | 54979.8 | 5.8801 | 0.00 | 64.24 | 0.1721 | 24.9658 | 248.30 | 0.8749 | 1.0097 | 11.5207 | 92.76 | 144.53 | 107132.6 | 745.8 | 26193.9 | 5.5640 | 6630.5 | 936.93 | 11502.3 | 6416.1 | 175.81 |
| TDD341 | Group 3 | 4.0312 | 15.8541 | 0.2515 | 16.0246 | 3.0873 | 2.9488 | 1.5896 | 29.8499 | 6.1572 | 29.2116 | 4.7200 | 0.6450 | 29709.9 | 7.0930 | 0.00 | 94.46 | 0.2442 | 16.1798 | 71.96 | 0.7765 | 0.3866 | 11.7264 | 75.31 | 137.30 | 90923.1 | 580.6 | 3466.3 | 2.4804 | 17306.0 | 142.35 | 8230.3 | 4185.1 | 112.68 |
| TDD346 | Group 3 | 4.0203 | 24.5573 | 0.4629 | 24.5217 | 6.0624 | 3.0945 | 3.2862 | 52.1697 | 12.9586 | 39.7152 | 5.1792 | 1.1768 | 45553.0 | 10.4535 | 0.00 | 100.47 | 0.2265 | 24.0272 | 172.70 | 0.7530 | 0.8635 | 10.6890 | 90.74 | 211.95 | 90651.6 | 756.8 | 13056.7 | 5.3939 | 16321.7 | 662.67 | 11998.1 | 4941.5 | 139.64 |
| TDD347 | Group 3 | 0.0000 | 23.6434 | 0.4492 | 24.8529 | 5.5682 | 1.7102 | 3.2548 | 55.6656 | 9.6151 | 25.9160 | 5.8228 | 1.2462 | 25885.0 | 6.5805 | 0.00 | 86.12 | 0.1788 | 17.7399 | 73.21 | 0.6438 | 0.8107 | 8.2375 | 70.08 | 124.90 | 87021.3 | 661.2 | 2790.3 | 5.3635 | 15499.7 | 279.80 | 5801.1 | 4020.5 | 87.58 |
| TDD349 | Group 3 | 3.5297 | 23.9097 | 0.3686 | 25.3224 | 5.2330 | 2.1016 | 2.6000 | 57.4580 | 16.8037 | 48.8481 | 4.2805 | 1.1844 | 48355.7 | 5.0250 | 0.00 | 77.73 | 0.2227 | 20.4425 | 235.04 | 0.7732 | 0.6443 | 9.2450 | 75.70 | 138.47 | 96178.0 | 608.6 | 21253.7 | 4.5967 | 13516.8 | 846.21 | 11939.6 | 4682.4 | 140.72 |
| TDD350 | Group 3 | 4.7899 | 44.5057 | 0.5361 | 43.2422 | 8.5711 | 2.8422 | 3.6750 | 94.7795 | 14.5707 | 43.5249 | 5.4689 | 1.9192 | 44908.6 | 8.9011 | 0.00 | 116.10 | 0.1661 | 23.2022 | 202.77 | 0.9853 | 1.1963 | 12.6491 | 88.97 | 211.94 | 106780.2 | 816.6 | 18596.6 | 7.4228 | 16247.7 | 568.87 | 9841.1 | 5480.0 | 145.29 |
| TDD352 | Group 3 | 0.0000 | 19.3841 | 0.4248 | 20.7301 | 4.7280 | 1.8974 | 3.0551 | 51.7816 | 9.5102 | 29.2489 | 5.8534 | 1.0823 | 24953.9 | 6.7320 | 0.00 | 90.13 | 0.1816 | 18.0375 | 0.00 | 0.6902 | 0.7000 | 8.5187 | 71.72 | 132.06 | 87084.6 | 522.0 | 2436.9 | 4.9293 | 15592.7 | 222.01 | 5066.2 | 5008.5 | 124.54 |
| TDD356 | Group 3 | 8.5486 | 23.7858 | 0.4022 | 26.7387 | 5.6563 | 1.9503 | 2.7582 | 61.9368 | 21.5940 | 36.6769 | 5.4123 | 1.2833 | 54541.0 | 5.5518 | 0.00 | 86.20 | 0.1695 | 27.8771 | 165.17 | 0.7308 | 0.8333 | 8.0185 | 88.45 | 143.85 | 97127.5 | 607.5 | 14802.5 | 4.9878 | 14265.4 | 829.67 | 10387.9 | 4328.0 | 180.20 |
| TDD358 | Group 3 | 4.8293 | 27.1242 | 0.5628 | 31.8207 | 7.7501 | 3.3993 | 3.8653 | 60.4112 | 16.1324 | 57.8123 | 4.5128 | 1.5959 | 66422.6 | 23.4697 | 0.00 | 58.70 | 0.2800 | 30.9659 | 222.65 | 0.8907 | 1.0711 | 10.3289 | 95.97 | 544.14 | 107596.3 | 596.9 | 25570.6 | 6.3903 | 9958.8 | 620.96 | 11456.9 | 6342.3 | 224.19 |
| TDD007 | Unassigned | 3.4468 | 24.9271 | 0.3152 | 25.3530 | 4.8511 | 1.7058 | 2.3264 | 45.7594 | 7.0894 | 23.9719 | 4.0592 | 1.1248 | 36992.5 | 6.2765 | 0.00 | 87.10 | 0.2635 | 15.2802 | 196.72 | 0.7049 | 0.5031 | 11.7232 | 66.76 | 155.42 | 103383.8 | 1101.9 | 17277.1 | 4.8012 | 13909.9 | 612.86 | 11095.8 | 4964.6 | 182.83 |
| TDD009 | Unassigned | 5.6073 | 38.4468 | 0.3836 | 36.5768 | 6.3008 | 2.4799 | 2.8221 | 90.3365 | 15.3447 | 28.9571 | 4.4731 | 1.3570 | 56576.5 | 6.9369 | 0.00 | 110.84 | 0.1933 | 18.6069 | 188.60 | 0.7819 | 0.7522 | 14.3599 | 82.45 | 157.47 | 100575.8 | 1360.7 | 8288.8 | 4.3726 | 14686.1 | 794.44 | 6923.9 | 5185.5 | 121.12 |
| TDD015 | Unassigned | 2.6702 | 25.4674 | 0.4072 | 27.8159 | 6.0261 | 2.6268 | 2.7905 | 54.1061 | 10.5987 | 26.6022 | 3.3043 | 1.5906 | 43625.4 | 12.5730 | 0.00 | 74.18 | 0.1963 | 22.5830 | 230.63 | 0.7435 | 0.7066 | 10.3324 | 75.06 | 302.30 | 104718.1 | 976.2 | 14646.0 | 5.0320 | 17231.8 | 295.78 | 8537.0 | 4963.8 | 133.86 |
| TDD017 | Unassigned | 2.8848 | 23.3243 | 0.3257 | 24.3294 | 4.4579 | 0.0000 | 2.1890 | 65.7898 | 42.0828 | 118.9593 | 1.9436 | 1.2487 | 57142.1 | 5.1741 | 0.00 | 55.86 | 0.1232 | 26.4178 | 268.36 | 0.4240 | 0.6893 | 6.2212 | 90.28 | 114.67 | 93916.2 | 815.1 | 35459.6 | 3.3897 | 7231.3 | 1238.90 | 10854.2 | 4809.2 | 156.91 |
| TDD024 | Unassigned | 8.7865 | 24.1523 | 0.3753 | 26.4725 | 5.5733 | 1.4849 | 2.7644 | 56.3370 | 13.6156 | 37.2023 | 5.3024 | 1.3049 | 55339.4 | 4.4583 | 0.00 | 81.05 | 0.1734 | 26.7977 | 141.38 | 0.8021 | 0.7160 | 8.7510 | 100.35 | 142.11 | 89245.2 | 894.7 | 9636.4 | 3.9884 | 18119.0 | 287.17 | 14132.6 | 3689.5 | 106.20 |
| TDD030 | Unassigned | 9.0020 | 24.4783 | 0.4181 | 20.5751 | 5.1267 | 6.7376 | 2.4005 | 52.9011 | 10.1454 | 36.3504 | 9.7902 | 1.0291 | 30605.8 | 11.2821 | 0.00 | 169.02 | 1.1812 | 18.4830 | 166.72 | 0.6139 | 0.6867 | 22.6137 | 83.67 | 290.80 | 100342.8 | 662.9 | 6698.3 | 3.4469 | 27680.7 | 364.90 | 7423.7 | 5171.7 | 153.17 |
| TDD032 | Unassigned | 5.4622 | 40.6311 | 0.3898 | 31.8546 | 6.7353 | 2.3286 | 2.7109 | 86.2777 | 14.3807 | 22.9086 | 4.9189 | 1.5983 | 52664.5 | 8.5249 | 0.00 | 116.00 | 0.3921 | 21.7350 | 177.00 | 0.7519 | 0.7214 | 11.8942 | 100.12 | 188.43 | 99861.3 | 1399.8 | 12167.3 | 4.6597 | 20971.8 | 715.01 | 11737.3 | 4265.7 | 114.32 |
| TDD034 | Unassigned | 3.2257 | 26.6041 | 0.4076 | 27.8485 | 6.0478 | 3.0199 | 2.6365 | 158.9123 | 16.7168 | 41.0925 | 4.2727 | 1.3960 | 50409.8 | 6.6871 | 0.00 | 62.79 | 0.1842 | 21.9113 | 397.56 | 1.4520 | 0.7010 | 9.9645 | 115.23 | 194.07 | 98706.8 | 955.4 | 24060.9 | 4.5586 | 11629.1 | 836.98 | 11982.5 | 5330.5 | 147.48 |
| TDD052 | Unassigned | 5.9748 | 24.6575 | 0.2791 | 28.5990 | 4.3126 | 3.3726 | 2.2867 | 46.0575 | 10.0716 | 27.9096 | 5.7694 | 0.8526 | 42060.4 | 5.5742 | 0.00 | 95.03 | 0.4327 | 20.1836 | 121.56 | 0.7892 | 0.5578 | 14.4880 | 84.46 | 114.62 | 102962.0 | 821.3 | 2084.3 | 2.6463 | 22047.4 | 185.06 | 8996.1 | 3772.7 | 112.67 |
| TDD053 | Unassigned | 5.6394 | 33.8904 | 0.4422 | 34.8699 | 7.7203 | 1.5345 | 3.2525 | 150.3350 | 29.8325 | 21.1972 | 3.7053 | 1.4815 | 44900.4 | 7.5817 | 0.00 | 94.48 | 0.4100 | 19.1537 | 157.06 | 0.6290 | 0.8919 | 8.1040 | 75.30 | 188.78 | 87158.8 | 788.3 | 13273.4 | 5.9976 | 14228.2 | 1716.47 | 15082.1 | 3599.2 | 95.92 |
| TDD064 | Unassigned | 5.7079 | 18.9848 | 0.3588 | 17.1330 | 4.4655 | 5.8354 | 2.5537 | 96.9270 | 34.4004 | 46.7096 | 4.2511 | 0.9669 | 48068.4 | 5.9427 | 0.00 | 88.55 | 0.2369 | 16.0734 | 0.00 | 0.6411 | 0.5207 | 10.6678 | 75.54 | 173.40 | 80747.7 | 453.9 | 3787.6 | 3.0880 | 12477.7 | 1199.01 | 4125.6 | 4091.3 | 126.39 |
| TDD065 | Unassigned | 5.5816 | 53.3641 | 0.5578 | 51.4728 | 9.6099 | 3.7387 | 3.6945 | 111.1395 | 9.9714 | 56.6880 | 5.7115 | 1.7893 | 44151.2 | 10.0595 | 0.00 | 97.20 | 0.1415 | 19.9839 | 325.24 | 1.2320 | 1.2290 | 17.2357 | 94.42 | 233.44 | 89119.2 | 1526.6 | 10653.2 | 8.6858 | 18175.4 | 548.29 | 8642.1 | 5450.7 | 111.37 |
| TDD069 | Unassigned | 3.5715 | 27.1151 | 0.3199 | 26.4276 | 5.5300 | 2.1813 | 2.4563 | 61.9052 | 12.9758 | 29.9992 | 5.1463 | 1.2625 | 46095.7 | 5.0713 | 0.00 | 92.83 | 0.2241 | 19.8661 | 217.92 | 0.8110 | 0.6166 | 11.3743 | 101.09 | 129.20 | 87974.8 | 922.5 | 7576.2 | 3.8065 | 15867.5 | 462.50 | 12411.1 | 3845.2 | 121.41 |
| TDD073 | Unassigned | 3.4987 | 30.0487 | 0.3663 | 26.8161 | 5.9459 | 1.6794 | 2.3397 | 63.6675 | 12.4936 | 27.1504 | 5.4270 | 1.3041 | 42643.5 | 5.2132 | 0.00 | 98.28 | 0.2077 | 18.0634 | 241.40 | 0.8157 | 0.9731 | 11.7798 | 79.49 | 116.92 | 92956.6 | 852.2 | 11595.7 | 4.3411 | 18954.7 | 613.04 | 13582.0 | 3603.3 | 105.33 |
| TDD081 | Unassigned | 3.2974 | 15.8797 | 0.2655 | 15.2051 | 3.9960 | 2.5891 | 1.7017 | 27.0541 | 21.1261 | 50.6240 | 4.8004 | 0.9277 | 47553.5 | 5.0495 | 0.00 | 108.38 | 0.2440 | 17.5718 | 76.60 | 0.6462 | 0.4502 | 11.4332 | 91.02 | 92.66 | 95107.0 | 865.9 | 7397.6 | 3.6209 | 18382.6 | 376.39 | 4490.9 | 5236.9 | 156.51 |
| TDD083 | Unassigned | 2.2488 | 28.3192 | 0.3510 | 22.9197 | 5.6667 | 2.5251 | 2.1962 | 57.6508 | 11.1839 | 22.2203 | 5.4300 | 1.2311 | 37101.9 | 5.2546 | 0.00 | 97.09 | 0.2082 | 15.7306 | 218.78 | 0.6897 | 0.6540 | 10.5171 | 70.71 | 132.41 | 94400.8 | 636.6 | 11153.7 | 4.1805 | 20838.1 | 455.01 | 16619.4 | 3523.6 | 104.60 |
| TDD087 | Unassigned | 3.0885 | 22.9391 | 0.3931 | 26.5806 | 5.8552 | 1.9478 | 2.8277 | 48.6119 | 10.0291 | 31.9632 | 3.2658 | 1.2981 | 48669.8 | 8.1597 | 0.00 | 83.24 | 0.1725 | 20.2501 | 262.09 | 0.6519 | 0.7291 | 8.1358 | 71.42 | 182.95 | 86777.2 | 829.3 | 12932.2 | 5.1344 | 13857.6 | 336.06 | 13781.2 | 4651.5 | 137.99 |
| TDD092 | Unassigned | 3.6581 | 23.7028 | 0.3420 | 26.3837 | 5.1954 | 3.4677 | 1.8334 | 47.5514 | 9.0250 | 25.8653 | 3.6840 | 1.3971 | 43220.6 | 10.1361 | 0.00 | 75.74 | 0.1825 | 20.4111 | 270.67 | 0.9269 | 0.6445 | 12.5098 | 88.45 | 241.07 | 109248.8 | 1599.6 | 13546.0 | 4.0794 | 15064.7 | 348.63 | 7004.8 | 4642.8 | 118.62 |
| TDD093 | Unassigned | 2.8968 | 29.0224 | 0.3234 | 30.4050 | 6.0814 | 2.3052 | 2.4471 | 49.9013 | 12.4428 | 32.4508 | 3.9913 | 1.6021 | 46303.5 | 12.0513 | 0.00 | 64.75 | 0.2010 | 21.6432 | 282.07 | 0.4857 | 0.6704 | 9.3642 | 78.98 | 304.14 | 117631.0 | 1263.7 | 21052.4 | 4.6518 | 12630.6 | 336.07 | 9957.0 | 4718.6 | 132.47 |
| TDD094 | Unassigned | 3.7453 | 18.3704 | 0.4142 | 22.1340 | 5.8844 | 2.3960 | 2.8226 | 64.3990 | 21.2859 | 19.7673 | 2.2418 | 1.4648 | 39970.2 | 14.5788 | 0.00 | 57.44 | 0.1908 | 18.5198 | 301.61 | 1.3798 | 0.9202 | 8.1315 | 66.93 | 378.31 | 91057.0 | 1379.6 | 14047.4 | 6.0058 | 14107.6 | 1164.36 | 8662.3 | 3761.0 | 86.81 |
| TDD102 | Unassigned | 36.3898 | 38.3078 | 0.4968 | 32.6468 | 8.1260 | 3.8783 | 3.0632 | 92.2610 | 42.5735 | 35.4071 | 4.8354 | 1.8101 | 72268.3 | 8.1156 | 0.00 | 69.15 | 0.6272 | 22.0410 | 207.12 | 0.6645 | 0.9374 | 14.2062 | 68.05 | 192.48 | 98580.3 | 513.1 | 12241.6 | 6.2394 | 10027.6 | 1502.75 | 10056.2 | 5372.6 | 206.65 |
| TDD105 | Unassigned | 3.4829 | 37.4851 | 0.4590 | 29.9806 | 6.3442 | 2.5100 | 3.2611 | 70.4592 | 12.3846 | 45.9452 | 3.0787 | 1.2130 | 41075.0 | 12.1077 | 0.00 | 81.42 | 0.1972 | 17.7972 | 222.61 | 0.8708 | 0.9877 | 11.7395 | 93.94 | 254.78 | 96113.9 | 1689.7 | 12033.6 | 6.4989 | 16522.7 | 612.17 | 10503.3 | 4742.0 | 121.73 |
| TDD106 | Unassigned | 3.0723 | 29.9675 | 0.3321 | 26.7258 | 5.9839 | 2.7170 | 2.5270 | 60.4536 | 11.1087 | 25.3328 | 5.1752 | 1.2267 | 40038.7 | 5.7778 | 0.00 | 100.98 | 0.1813 | 17.6113 | 222.84 | 0.7735 | 0.7176 | 11.2436 | 94.48 | 139.88 | 88172.1 | 978.8 | 12400.5 | 4.4250 | 18490.5 | 511.48 | 14420.3 | 3720.9 | 105.71 |
| TDD108 | Unassigned | 6.2355 | 25.3511 | 0.3322 | 25.2557 | 5.8030 | 2.2475 | 2.6251 | 41.6891 | 10.4883 | 55.5855 | 4.7623 | 1.6428 | 41257.0 | 6.5670 | 25.63 | 98.30 | 0.2510 | 18.2866 | 234.06 | 0.6220 | 0.7873 | 5.5929 | 63.72 | 168.31 | 87406.5 | 1209.3 | 13697.7 | 5.1155 | 15255.3 | 390.42 | 10279.0 | 3962.9 | 88.38 |
| TDD121 | Unassigned | 5.7155 | 22.0057 | 0.2808 | 25.9995 | 4.5325 | 2.0970 | 1.9546 | 57.7264 | 30.3060 | 48.1913 | 4.1384 | 1.1264 | 57840.6 | 7.3551 | 0.00 | 86.92 | 0.2761 | 21.7864 | 292.65 | 0.7370 | 0.4976 | 8.5720 | 72.28 | 175.35 | 106520.7 | 1793.8 | 10256.9 | 3.3043 | 12918.8 | 555.59 | 6350.9 | 5371.0 | 171.34 |
| TDD122 | Unassigned | 3.5418 | 27.6513 | 0.3414 | 31.8680 | 6.1444 | 3.1223 | 2.2211 | 52.3864 | 10.6228 | 30.8947 | 3.8316 | 1.4905 | 42738.2 | 12.8678 | 0.00 | 61.57 | 0.2043 | 21.7570 | 312.93 | 0.5284 | 0.6881 | 9.9172 | 72.19 | 324.73 | 113069.5 | 1558.7 | 21583.5 | 4.6918 | 13069.2 | 356.45 | 9417.4 | 4406.2 | 124.60 |
| TDD128 | Unassigned | 3.5693 | 17.5443 | 0.3270 | 21.0362 | 4.8707 | 1.0858 | 2.3836 | 41.8359 | 22.9993 | 43.1569 | 4.3494 | 1.1770 | 54204.8 | 3.8887 | 0.00 | 59.67 | 0.1809 | 24.2231 | 235.41 | 0.4290 | 0.6122 | 4.2204 | 96.29 | 73.25 | 103828.5 | 588.3 | 23947.0 | 3.3896 | 10876.5 | 896.40 | 10024.0 | 5800.3 | 153.76 |

| anid | Chemical Group | As | La | Lu | Nd | Sm | U | Yb | Ce | Co | Cr | Cs | Eu | Fe | Hf | Ni | Rb | Sb | Sc | Sr | Ta | Tb | Th | Zn | Zr | Al | Ba | Ca | Dy | K | Mn | Na | Ti | V |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TDD133 | Unassigned | 4.2119 | 21.0786 | 0.3500 | 22.9295 | 5.1833 | 2.1723 | 2.2412 | 40.3695 | 9.9643 | 29.1945 | 2.8162 | 1.2081 | 49726.4 | 11.6657 | 0.00 | 68.13 | 0.1892 | 20.1638 | 160.34 | 0.8350 | 0.6731 | 9.0746 | 64.29 | 271.55 | 80787.2 | 614.1 | 14788.9 | 3.7918 | 10475.7 | 358.21 | 8273.3 | 4201.2 | 134.66 |
| TDD135 | Unassigned | 2.0172 | 14.5304 | 0.2797 | 15.0088 | 3.8828 | 2.6375 | 1.7146 | 39.1252 | 10.4816 | 20.6634 | 2.4707 | 1.1442 | 30688.3 | 9.5384 | 0.00 | 50.90 | 0.1489 | 15.5313 | 270.29 | 0.7747 | 0.6208 | 5.5929 | 38.17 | 237.29 | 97683.1 | 502.9 | 27064.0 | 2.6679 | 10262.9 | 482.31 | 16469.2 | 3020.1 | 83.23 |
| TDD140 | Unassigned | 4.7527 | 33.6504 | 0.4289 | 31.4307 | 7.1247 | 2.3976 | 3.3662 | 76.9106 | 22.1610 | 115.5541 | 5.6388 | 1.3726 | 47292.3 | 6.0976 | 0.00 | 72.57 | 0.1523 | 22.7585 | 76.53 | 0.9698 | 0.8404 | 13.1129 | 75.34 | 142.08 | 107978.5 | 339.5 | 4924.0 | 5.8169 | 9849.4 | 545.96 | 4356.7 | 6640.5 | 186.30 |
| TDD143 | Unassigned | 4.5278 | 30.0823 | 0.5821 | 38.5484 | 10.1625 | 3.0038 | 4.4767 | 58.9472 | 9.6211 | 28.5534 | 2.8631 | 2.4404 | 53573.8 | 10.0330 | 0.00 | 47.52 | 0.0827 | 26.8908 | 180.72 | 0.8860 | 1.4596 | 9.9955 | 54.22 | 302.74 | 100489.6 | 347.3 | 22302.1 | 9.0809 | 10071.9 | 454.54 | 12344.6 | 6129.5 | 166.31 |
| TDD146 | Unassigned | 0.0000 | 50.0014 | 0.4237 | 41.6922 | 8.6273 | 2.8573 | 3.4922 | 107.2332 | 8.8181 | 38.9326 | 5.3508 | 1.9071 | 31783.4 | 7.3903 | 0.00 | 126.05 | 0.1615 | 22.8437 | 94.61 | 0.8952 | 1.2014 | 18.2000 | 94.11 | 161.86 | 125000.3 | 528.7 | 7295.3 | 6.3147 | 13983.2 | 194.08 | 8605.5 | 5518.9 | 112.56 |
| TDD150 | Unassigned | 4.0542 | 25.6551 | 0.3342 | 24.6552 | 5.5992 | 3.0081 | 2.6428 | 66.2485 | 13.4907 | 24.7909 | 4.9250 | 1.2214 | 39296.5 | 5.7548 | 0.00 | 91.64 | 0.2727 | 16.9847 | 192.09 | 0.7368 | 0.7329 | 11.5010 | 67.80 | 163.61 | 90617.7 | 1023.2 | 9477.0 | 4.0352 | 18891.9 | 564.20 | 12904.0 | 3168.3 | 111.21 |
| TDD151 | Unassigned | 2.2517 | 22.6335 | 0.6486 | 23.1064 | 6.1130 | 2.7172 | 4.9854 | 62.7308 | 13.8715 | 40.1280 | 3.8523 | 1.3154 | 51884.2 | 13.1918 | 0.00 | 83.76 | 0.2700 | 26.6073 | 202.93 | 0.8720 | 0.8136 | 10.2932 | 72.67 | 304.13 | 102839.4 | 885.9 | 20193.6 | 5.0429 | 13745.2 | 727.50 | 11168.5 | 4639.6 | 143.03 |
| TDD152 | Unassigned | 5.7964 | 28.5601 | 0.3407 | 25.6035 | 5.6249 | 2.0878 | 2.6249 | 85.0781 | 21.4544 | 27.5238 | 5.2297 | 1.2473 | 43693.9 | 6.1801 | 0.00 | 86.00 | 0.2883 | 17.4022 | 167.10 | 0.7254 | 1.0023 | 11.0014 | 72.16 | 168.73 | 87262.2 | 1252.2 | 8338.0 | 3.5079 | 16542.8 | 1238.56 | 11485.1 | 3278.2 | 128.28 |
| TDD160 | Unassigned | 4.4135 | 11.5341 | 0.3159 | 12.5756 | 3.9167 | 1.9805 | 1.8375 | 27.8196 | 5.8406 | 90.3333 | 7.7263 | 0.9480 | 25643.2 | 7.2119 | 0.00 | 96.00 | 0.3141 | 24.1496 | 119.41 | 1.0433 | 0.5706 | 12.0561 | 101.79 | 194.99 | 132574.0 | 576.5 | 1626.3 | 3.7216 | 12747.1 | 145.25 | 6015.5 | 9227.7 | 210.80 |
| TDD161 | Unassigned | 2.0515 | 31.8819 | 0.3989 | 29.5689 | 6.9630 | 2.6912 | 3.0150 | 65.1415 | 6.2089 | 23.1137 | 3.7632 | 1.9192 | 30181.0 | 11.8407 | 0.00 | 82.15 | 0.1978 | 22.6908 | 221.93 | 0.8247 | 1.1683 | 11.0218 | 65.18 | 343.55 | 108346.5 | 428.7 | 22859.0 | 4.9586 | 14164.1 | 230.93 | 14317.2 | 4446.0 | 110.78 |
| TDD162 | Unassigned | 2.2889 | 17.6732 | 0.3299 | 20.7935 | 4.2019 | 1.8575 | 2.6377 | 61.7844 | 18.9696 | 29.6192 | 5.5297 | 1.0084 | 24826.4 | 7.3904 | 0.00 | 92.03 | 0.2116 | 17.1016 | 36.31 | 0.6708 | 0.5509 | 8.0180 | 71.87 | 193.23 | 81850.4 | 633.4 | 3879.1 | 3.6851 | 18253.7 | 276.10 | 6192.5 | 4363.8 | 104.15 |
| TDD163 | Unassigned | 4.2622 | 40.1540 | 0.4022 | 37.1459 | 7.5984 | 2.5828 | 2.9890 | 83.8494 | 17.8798 | 47.0573 | 4.5846 | 1.3186 | 52140.5 | 9.4701 | 0.00 | 83.32 | 0.2333 | 24.3818 | 165.96 | 0.7697 | 0.8774 | 11.9822 | 85.20 | 252.61 | 91649.3 | 497.0 | 18215.6 | 4.1283 | 12065.8 | 804.17 | 10450.2 | 5297.8 | 160.89 |
| TDD165 | Unassigned | 1.6966 | 50.9102 | 0.2958 | 43.0875 | 7.9124 | 1.8419 | 2.5332 | 99.4889 | 5.3599 | 16.0309 | 3.0654 | 2.0822 | 37685.6 | 7.8859 | 0.00 | 93.82 | 0.1032 | 13.2335 | 227.84 | 0.6349 | 0.9549 | 11.6908 | 69.13 | 246.38 | 97138.9 | 1448.4 | 12618.2 | 5.2198 | 16054.7 | 209.93 | 8910.4 | 2952.9 | 75.22 |
| TDD168 | Unassigned | 3.1365 | 8.2872 | 0.3033 | 7.1800 | 2.2613 | 2.0806 | 1.9127 | 31.5621 | 10.6700 | 29.0205 | 9.4248 | 0.6072 | 41393.7 | 5.8011 | 0.00 | 119.26 | 0.2528 | 16.9297 | 41.79 | 0.6803 | 0.3704 | 8.5300 | 108.17 | 137.76 | 96684.0 | 350.1 | 2292.1 | 2.7666 | 18329.4 | 341.28 | 1864.5 | 3535.7 | 96.04 |
| TDD169 | Unassigned | 3.0543 | 15.4425 | 0.3689 | 17.6656 | 4.3786 | 1.0169 | 2.7189 | 32.2376 | 8.5619 | 22.7224 | 4.4693 | 1.2749 | 35223.1 | 5.1416 | 0.00 | 30.85 | 0.1507 | 16.5891 | 144.79 | 0.3077 | 0.7523 | 3.8853 | 60.32 | 131.91 | 90808.7 | 263.6 | 14591.7 | 4.3480 | 8153.4 | 634.34 | 18857.8 | 4047.9 | 84.85 |
| TDD170 | Unassigned | 0.0000 | 10.4902 | 0.3030 | 10.4024 | 2.5642 | 2.5222 | 2.0915 | 36.1122 | 10.8118 | 31.9951 | 9.3524 | 0.6177 | 41348.3 | 5.4111 | 0.00 | 118.75 | 0.3332 | 17.0177 | 0.00 | 0.6690 | 0.3417 | 9.5422 | 107.84 | 152.77 | 98840.3 | 365.7 | 2485.7 | 2.4844 | 20343.5 | 393.64 | 1890.4 | 3711.9 | 83.97 |
| TDD172 | Unassigned | 7.3975 | 35.2952 | 0.5061 | 33.8059 | 7.6572 | 2.6054 | 3.5260 | 74.8504 | 13.4180 | 48.4184 | 7.4913 | 1.6581 | 53722.9 | 7.2965 | 0.00 | 77.21 | 0.4515 | 22.2534 | 0.00 | 0.8315 | 1.2446 | 13.4351 | 87.27 | 204.23 | 108553.4 | 356.4 | 2850.0 | 5.8170 | 16348.7 | 1339.30 | 5350.4 | 7055.5 | 181.27 |
| TDD176 | Unassigned | 5.0258 | 21.5912 | 0.4177 | 22.3616 | 5.1717 | 2.3957 | 3.3664 | 52.9481 | 7.1557 | 17.2972 | 6.8787 | 1.1866 | 40296.6 | 6.4404 | 0.00 | 95.63 | 0.1962 | 17.4702 | 42.33 | 0.8440 | 0.7172 | 11.7469 | 93.56 | 167.25 | 107614.1 | 418.6 | 2833.5 | 4.7623 | 20201.5 | 534.92 | 2260.0 | 3947.4 | 102.22 |
| TDD178 | Unassigned | 2.1664 | 8.5301 | 0.3310 | 8.2456 | 2.2541 | 1.9904 | 2.1730 | 31.5249 | 10.3522 | 27.7937 | 10.4675 | 0.5888 | 40754.6 | 5.8450 | 0.00 | 121.16 | 0.3190 | 16.3368 | 50.50 | 0.6664 | 0.3029 | 8.4396 | 128.42 | 142.32 | 102580.9 | 406.7 | 1964.8 | 2.1770 | 20922.3 | 354.67 | 2026.5 | 4133.9 | 83.35 |
| TDD179 | Unassigned | 4.5369 | 5.7665 | 0.1191 | 5.9506 | 1.6002 | 1.3879 | 1.0897 | 17.2153 | 6.4633 | 54.3718 | 8.1024 | 0.4366 | 40618.4 | 3.2143 | 0.00 | 43.05 | 0.3207 | 18.4511 | 0.00 | 0.3695 | 0.1858 | 4.0251 | 54.21 | 85.79 | 67736.8 | 746.4 | 2157.1 | 1.7608 | 5816.4 | 154.79 | 3683.1 | 4848.4 | 140.33 |
| TDD180 | Unassigned | 2.3915 | 27.4108 | 0.5497 | 33.8347 | 8.2924 | 2.4612 | 4.2104 | 66.1076 | 9.9713 | 41.0788 | 8.1389 | 2.1725 | 34155.6 | 8.3603 | 0.00 | 150.82 | 0.3278 | 33.0476 | 0.00 | 0.6989 | 1.3335 | 9.4305 | 116.03 | 227.42 | 141881.7 | 511.2 | 2268.3 | 7.6174 | 20444.6 | 457.66 | 2241.5 | 9068.4 | 129.32 |
| TDD181 | Unassigned | 5.8816 | 28.2603 | 0.3281 | 24.0562 | 5.4136 | 2.1085 | 2.6777 | 68.8164 | 11.8915 | 27.2091 | 9.7144 | 1.0963 | 37173.5 | 6.0745 | 0.00 | 167.73 | 0.2144 | 15.3775 | 92.46 | 0.7953 | 0.6926 | 21.2879 | 82.32 | 143.61 | 90488.4 | 615.8 | 2228.7 | 3.9628 | 32695.5 | 535.21 | 5616.1 | 3604.2 | 88.54 |
| TDD182 | Unassigned | 1.8256 | 32.6562 | 0.3023 | 27.1205 | 5.5470 | 1.9481 | 2.3073 | 72.2420 | 6.0490 | 17.6993 | 6.8490 | 1.0834 | 27640.2 | 5.6620 | 0.00 | 120.54 | 0.0851 | 10.8899 | 42.32 | 0.7037 | 0.6659 | 20.8826 | 60.46 | 153.43 | 86870.2 | 503.7 | 1337.9 | 3.4663 | 23531.2 | 224.49 | 4304.4 | 2613.4 | 76.90 |
| TDD184 | Unassigned | 5.3044 | 16.2246 | 0.3166 | 17.3338 | 3.8748 | 1.6972 | 2.2398 | 38.4379 | 16.0357 | 25.7804 | 4.4279 | 1.1885 | 55249.7 | 4.5832 | 0.00 | 111.77 | 0.4270 | 19.0171 | 272.97 | 0.5115 | 0.4532 | 6.1988 | 105.73 | 139.15 | 98605.7 | 294.9 | 24332.0 | 2.6113 | 26833.1 | 919.92 | 18163.5 | 5559.7 | 137.23 |
| TDD186 | Unassigned | 10.7823 | 33.3348 | 0.4370 | 23.0850 | 5.2275 | 2.1678 | 3.1804 | 70.8045 | 10.5640 | 15.3468 | 10.5197 | 1.1518 | 37791.3 | 5.1095 | 0.00 | 103.02 | 0.6632 | 13.8781 | 34.94 | 1.0330 | 0.7126 | 21.0991 | 84.01 | 132.28 | 82502.0 | 414.8 | 4342.4 | 3.9948 | 16219.2 | 594.92 | 2770.9 | 3553.4 | 96.87 |
| TDD187 | Unassigned | 4.4610 | 28.4307 | 0.3483 | 26.7621 | 5.1396 | 2.3428 | 2.3708 | 62.1647 | 10.1981 | 23.3568 | 9.9812 | 1.1522 | 37166.3 | 5.6824 | 0.00 | 163.54 | 0.1548 | 14.2109 | 101.51 | 0.6441 | 0.6006 | 17.4002 | 76.38 | 152.04 | 91138.5 | 547.6 | 3728.3 | 3.6538 | 32101.8 | 538.67 | 3139.1 | 3370.1 | 89.66 |
| TDD188 | Unassigned | 3.0039 | 14.5248 | 0.4647 | 18.2543 | 4.7051 | 1.0360 | 3.5076 | 28.6713 | 18.1347 | 143.1431 | 4.7085 | 1.2892 | 42625.0 | 5.4785 | 0.00 | 82.40 | 0.2448 | 24.0684 | 106.43 | 0.3338 | 0.7556 | 4.1730 | 90.43 | 113.22 | 89328.7 | 178.5 | 13630.4 | 4.7907 | 11029.7 | 1065.67 | 14575.1 | 4974.5 | 164.95 |
| TDD189 | Unassigned | 11.3535 | 34.4121 | 0.4854 | 27.1842 | 5.4146 | 2.3830 | 3.2738 | 75.4977 | 11.6816 | 14.5326 | 12.6476 | 1.1581 | 39036.1 | 4.7004 | 0.00 | 118.50 | 0.6383 | 14.0336 | 0.00 | 1.0872 | 0.6587 | 22.1817 | 95.39 | 115.75 | 90021.5 | 347.8 | 4058.0 | 4.3034 | 18647.1 | 841.46 | 3369.5 | 2902.9 | 111.88 |
| TDD190 | Unassigned | 9.6580 | 24.1099 | 0.4199 | 29.0524 | 6.2355 | 1.4671 | 2.6366 | 53.4058 | 25.1199 | 56.5448 | 12.2154 | 1.6498 | 68544.1 | 4.8490 | 0.00 | 88.71 | 0.3511 | 25.4586 | 221.69 | 0.5744 | 0.7439 | 7.8592 | 114.55 | 123.88 | 102634.0 | 456.2 | 18577.0 | 4.4881 | 12977.9 | 1111.23 | 11926.0 | 5677.9 | 195.69 |
| TDD191 | Unassigned | 3.2990 | 21.0372 | 0.4306 | 16.4252 | 4.1664 | 2.4392 | 2.9364 | 42.8451 | 6.2637 | 37.4868 | 3.1257 | 0.8587 | 20747.1 | 14.9077 | 0.00 | 84.04 | 0.2774 | 11.0292 | 0.00 | 1.2197 | 0.7459 | 7.2589 | 53.26 | 369.33 | 39522.6 | 271.4 | 185.5 | 4.3095 | 9222.9 | 761.42 | 2086.5 | 7210.7 | 74.87 |
| TDD192 | Unassigned | 2.0232 | 39.8867 | 0.4932 | 29.6964 | 5.6002 | 3.5595 | 3.3657 | 55.5972 | 2.9200 | 75.0213 | 17.9132 | 1.0535 | 8296.9 | 10.2146 | 0.00 | 140.49 | 0.4049 | 18.5838 | 0.00 | 1.8120 | 1.0691 | 8.6182 | 42.08 | 276.18 | 121495.8 | 525.4 | 542.2 | 5.0807 | 20633.3 | 67.25 | 927.6 | 7820.7 | 158.15 |
| TDD193 | Unassigned | 5.9407 | 25.0917 | 0.5103 | 24.9581 | 5.4936 | 2.3289 | 3.6156 | 53.9236 | 9.7046 | 53.0663 | 3.7426 | 1.1800 | 35316.5 | 11.5882 | 0.00 | 70.80 | 0.3882 | 13.9771 | 0.00 | 1.1128 | 0.9090 | 7.7976 | 53.64 | 305.72 | 50706.3 | 302.8 | 767.9 | 4.3210 | 8544.7 | 501.02 | 3579.7 | 5876.8 | 110.58 |
| TDD194 | Unassigned | 5.6161 | 18.0159 | 0.4313 | 19.4163 | 4.2965 | 2.4205 | 2.7989 | 44.5866 | 9.6946 | 50.4852 | 2.7892 | 0.8923 | 29043.3 | 10.7517 | 0.00 | 52.93 | 0.3710 | 10.6789 | 0.00 | 1.0086 | 0.8223 | 6.2990 | 40.65 | 276.31 | 43149.1 | 293.5 | 0.0 | 3.0749 | 7466.2 | 820.46 | 3593.9 | 5501.8 | 98.88 |
| TDD195 | Unassigned | 4.5620 | 21.7055 | 0.4426 | 21.9231 | 4.9871 | 2.7801 | 3.1910 | 45.9530 | 12.1917 | 43.6974 | 3.3684 | 1.0673 | 27274.4 | 11.1231 | 0.00 | 62.22 | 0.2950 | 11.9300 | 0.00 | 1.0632 | 0.7287 | 6.8929 | 46.81 | 295.62 | 48451.7 | 250.0 | 894.6 | 4.2431 | 9313.0 | 867.99 | 3978.8 | 6469.8 | 100.25 |
| TDD196 | Unassigned | 3.6629 | 33.3674 | 0.4723 | 31.3095 | 6.3256 | 3.3210 | 3.4270 | 62.7694 | 8.9382 | 47.2286 | 5.1609 | 1.3185 | 26246.9 | 11.2110 | 0.00 | 90.29 | 0.3070 | 15.9174 | 0.00 | 1.2395 | 1.1471 | 8.3567 | 70.72 | 282.18 | 59072.7 | 335.1 | 682.4 | 5.2481 | 9531.4 | 739.12 | 1359.3 | 7037.3 | 121.89 |
| TDD197 | Unassigned | 8.0795 | 20.5074 | 0.3979 | 17.7864 | 4.3935 | 2.7416 | 2.4891 | 35.7468 | 4.3290 | 65.5353 | 7.3560 | 0.8094 | 44225.0 | 8.6243 | 0.00 | 112.05 | 0.4670 | 17.8540 | 0.00 | 1.0810 | 0.5925 | 10.4839 | 57.70 | 217.92 | 83960.2 | 347.8 | 1246.9 | 3.5511 | 12918.1 | 135.48 | 1407.3 | 5687.8 | 160.32 |
| TDD198 | Unassigned | 8.9825 | 24.3650 | 0.3663 | 23.9237 | 4.7284 | 3.5416 | 2.4993 | 91.5544 | 32.6613 | 72.7132 | 9.6544 | 0.8950 | 44583.4 | 8.2476 | 0.00 | 117.17 | 0.5475 | 21.6229 | 0.00 | 1.1384 | 0.6052 | 11.3129 | 73.62 | 200.78 | 108133.7 | 338.7 | 0.0 | 3.6691 | 12878.9 | 963.89 | 1032.9 | 5191.9 | 166.23 |
| TDD199 | Unassigned | 11.6714 | 26.4067 | 0.5679 | 27.4855 | 6.4281 | 2.4492 | 3.7688 | 65.8502 | 16.6164 | 70.6021 | 7.2576 | 1.4247 | 66835.1 | 7.5574 | 0.00 | 112.29 | 0.6311 | 24.8702 | 0.00 | 0.9981 | 0.9386 | 11.2604 | 94.41 | 159.60 | 110367.8 | 261.0 | 1571.9 | 5.4329 | 9654.6 | 1058.81 | 1513.2 | 5771.1 | 172.40 |
| TDD200 | Unassigned | 7.3371 | 20.3817 | 0.4156 | 19.1732 | 4.5975 | 2.4189 | 2.9804 | 54.7920 | 12.5969 | 58.7109 | 3.3251 | 0.9596 | 37018.9 | 9.8333 | 0.00 | 62.68 | 0.3835 | 12.2018 | 0.00 | 1.0251 | 0.8925 | 6.7806 | 46.63 | 272.29 | 46444.6 | 275.2 | 824.4 | 3.7510 | 7242.9 | 766.81 | 3746.6 | 5493.7 | 101.56 |
| TDD201 | Unassigned | 3.5519 | 20.0773 | 0.4180 | 17.1955 | 3.7561 | 2.7980 | 3.2401 | 38.3580 | 13.3567 | 58.1348 | 8.0059 | 0.6926 | 32231.0 | 12.9082 | 0.00 | 108.01 | 0.4003 | 14.8511 | 0.00 | 1.2588 | 0.5249 | 8.8312 | 61.53 | 310.32 | 75378.9 | 462.3 | 493.3 | 3.4042 | 15232.9 | 391.17 | 939.2 | 5692.1 | 129.73 |
| TDD202 | Unassigned | 8.2267 | 19.9446 | 0.3452 | 17.5518 | 4.0839 | 2.8979 | 2.9217 | 36.6898 | 10.7350 | 60.3464 | 6.9558 | 0.7738 | 41958.4 | 8.3892 | 0.00 | 107.35 | 0.5138 | 17.2735 | 0.00 | 1.0235 | 0.5160 | 9.7231 | 58.49 | 210.10 | 80199.6 | 337.8 | 882.8 | 3.2178 | 11482.6 | 252.80 | 1220.8 | 4995.4 | 158.94 |
| TDD203 | Unassigned | 20.2612 | 16.2936 | 0.3270 | 16.7353 | 3.7504 | 2.6163 | 2.4592 | 103.3665 | 96.9235 | 84.8216 | 3.4543 | 0.7456 | 74750.3 | 9.6231 | 0.00 | 71.04 | 1.1424 | 11.8132 | 0.00 | 0.8722 | 0.4497 | 8.2740 | 50.26 | 224.07 | 55081.7 | 0.0 | 1176.3 | 1.8560 | 11981.4 | 3249.71 | 1510.6 | 3894.4 | 175.75 |
| TDD204 | Unassigned | 6.1545 | 36.8728 | 0.4587 | 30.0744 | 6.2674 | 3.2306 | 3.4007 | 68.0171 | 6.6775 | 93.2917 | 11.8372 | 1.1678 | 35166.5 | 7.4714 | 0.00 | 130.66 | 0.4890 | 22.8857 | 0.00 | 1.3084 | 1.0427 | 13.9247 | 82.49 | 199.14 | 123482.2 | 557.8 | 360.2 | 5.1198 | 21691.7 | 112.83 | 949.7 | 4964.7 | 186.88 |
| TDD205 | Unassigned | 7.0623 | 23.5125 | 0.5333 | 22.9777 | 5.3198 | 3.1562 | 3.8653 | 55.4805 | 16.7336 | 55.0621 | 3.5264 | 1.0692 | 35675.8 | 10.1416 | 0.00 | 71.43 | 0.3987 | 12.6532 | 0.00 | 1.0132 | 0.8730 | 8.3097 | 50.78 | 262.74 | 48123.7 | 285.9 | 748.5 | 4.5999 | 9056.2 | 860.00 | 3327.8 | 5915.1 | 118.60 |
| TDD206 | Unassigned | 6.8470 | 23.1827 | 0.4331 | 26.9281 | 5.0544 | 3.1420 | 3.0806 | 59.5033 | 13.0646 | 49.7096 | 3.5419 | 1.0346 | 40830.5 | 9.3504 | 0.00 | 76.20 | 0.4020 | 12.6552 | 47.18 | 1.0376 | 0.7292 | 7.9274 | 52.91 | 195.12 | 54927.9 | 261.5 | 435.2 | 4.5578 | 9254.8 | 876.69 | 3421.9 | 5604.1 | 117.15 |
| TDD207 | Unassigned | 4.0697 | 20.0807 | 0.4701 | 15.2901 | 3.9664 | 2.9612 | 3.2101 | 39.3131 | 6.1545 | 36.1672 | 3.1596 | 0.8004 | 21908.1 | 13.7443 | 0.00 | 76.38 | 0.3147 | 10.6118 | 0.00 | 1.1199 | 0.7060 | 6.6647 | 53.83 | 327.11 | 43323.5 | 251.4 | 804.3 | 4.4719 | 10598.7 | 814.60 | 1759.1 | 6389.4 | 90.65 |
| TDD208 | Unassigned | 4.4120 | 27.5875 | 0.4039 | 21.6540 | 3.8016 | 1.9386 | 2.4867 | 43.6959 | 7.0937 | 72.5188 | 9.0108 | 0.7120 | 29568.0 | 9.5258 | 0.00 | 123.80 | 0.4300 | 17.2778 | 0.00 | 1.2171 | 0.5341 | 10.4427 | 67.54 | 243.54 | 93462.2 | 509.5 | 406.4 | 3.6617 | 17767.2 | 338.33 | 1098.7 | 5765.8 | 147.83 |
| TDD209 | Unassigned | 4.0632 | 21.4944 | 0.4080 | 18.8112 | 4.1628 | 1.9133 | 2.6733 | 45.9217 | 6.8058 | 33.5544 | 3.0676 | 0.8612 | 22540.5 | 13.5214 | 0.00 | 79.06 | 0.2915 | 11.0846 | 0.00 | 1.1044 | 0.6238 | 7.1101 | 52.70 | 348.63 | 42666.9 | 253.8 | 913.6 | 3.8667 | 9503.7 | 838.16 | 1707.3 | 5815.7 | 90.84 |
| TDD210 | Unassigned | 14.6593 | 15.1213 | 0.3177 | 17.2510 | 3.0613 | 2.3550 | 2.1670 | 43.7994 | 36.1883 | 59.1727 | 4.5896 | 0.5900 | 65234.1 | 8.5426 | 0.00 | 64.35 | 0.7415 | 13.4637 | 0.00 | 0.8241 | 0.4608 | 6.7963 | 46.88 | 207.24 | 53774.4 | 289.7 | 757.7 | 2.3199 | 8213.5 | 935.77 | 807.4 | 3379.7 | 133.16 |
| TDD211 | Unassigned | 14.7110 | 14.8824 | 0.3479 | 13.4205 | 3.5244 | 1.9241 | 2.3009 | 63.1002 | 51.6894 | 45.7148 | 4.6405 | 0.7086 | 45976.2 | 9.1105 | 0.00 | 85.15 | 0.5191 | 15.1580 | 0.00 | 0.8774 | 0.5297 | 7.8451 | 54.39 | 219.04 | 64685.5 | 347.3 | 0.0 | 2.8493 | 9156.6 | 2192.46 | 1310.3 | 5116.1 | 151.66 |
| TDD212 | Unassigned | 3.5191 | 29.9356 | 0.5377 | 25.3439 | 6.4770 | 2.6527 | 3.7259 | 62.5433 | 13.2901 | 41.0559 | 3.6305 | 1.3839 | 20376.9 | 13.5563 | 0.00 | 81.95 | 0.3156 | 13.7316 | 0.00 | 1.2548 | 0.9467 | 8.0335 | 60.31 | 345.34 | 49163.0 | 357.0 | 947.0 | 6.0231 | 10216.6 | 1423.70 | 1765.9 | 6792.5 | 81.60 |
| TDD213 | Unassigned | 3.7012 | 21.5279 | 0.4446 | 19.3219 | 4.5335 | 3.1228 | 2.9049 | 43.6290 | 8.3262 | 38.8618 | 3.3026 | 0.9099 | 20471.1 | 13.1417 | 0.00 | 73.29 | 0.3219 | 11.2896 | 0.00 | 1.2103 | 0.7257 | 7.2128 | 49.03 | 336.86 | 44191.3 | 236.4 | 0.0 | 4.2368 | 7295.0 | 1331.96 | 1758.9 | 5565.6 | 85.40 |
| TDD214 | Unassigned | 4.7481 | 21.2576 | 0.4324 | 23.7339 | 4.7676 | 2.3400 | 2.9765 | 50.1459 | 10.9851 | 46.1063 | 2.9774 | 1.0096 | 28022.0 | 11.8061 | 0.00 | 59.50 | 0.3162 | 12.5854 | 0.00 | 1.0780 | 0.7927 | 6.8389 | 48.41 | 291.86 | 44949.2 | 305.0 | 0.0 | 3.8599 | 8267.3 | 819.49 | 3459.3 | 5969.5 | 99.56 |
| TDD215 | Unassigned | 6.9149 | 19.1308 | 0.4711 | 17.1544 | 4.0710 | 3.7056 | 2.7797 | 46.4097 | 11.6047 | 55.2563 | 4.6617 | 0.7584 | 38656.6 | 12.5506 | 0.00 | 79.76 | 0.4041 | 14.8209 | 0.00 | 1.2008 | 0.5760 | 8.7136 | 56.06 | 307.53 | 61116.8 | 327.6 | 432.2 | 4.0289 | 10795.3 | 644.27 | 1274.2 | 6202.5 | 139.58 |
| TDD216 | Unassigned | 5.7670 | 36.7398 | 0.4965 | 30.7542 | 6.0849 | 3.0268 | 3.4085 | 63.2762 | 5.1878 | 91.7965 | 11.9992 | 1.1313 | 31943.1 | 7.8365 | 0.00 | 129.36 | 0.4881 | 23.3219 | 0.00 | 1.3507 | 0.9951 | 12.3402 | 66.84 | 209.27 | 126643.6 | 608.0 | 189.9 | 5.0483 | 20656.2 | 91.61 | 977.6 | 5798.1 | 178.29 |
| TDD217 | Unassigned | 6.5749 | 17.4350 | 0.4121 | 17.4024 | 3.7525 | 2.6367 | 2.5943 | 40.3928 | 8.9782 | 48.8492 | 4.9168 | 0.7547 | 33691.7 | 11.2992 | 0.00 | 89.27 | 0.4142 | 14.2006 | 0.00 | 1.0404 | 0.5706 | 8.1286 | 53.33 | 286.47 | 60617.1 | 367.2 | 840.1 | 3.4677 | 8197.1 | 448.90 | 1386.7 | 5956.3 | 119.05 |
| TDD218 | Unassigned | 5.8971 | 28.5816 | 0.3867 | 21.3745 | 4.0905 | 3.0359 | 2.5816 | 47.6940 | 8.3483 | 72.7358 | 9.0209 | 0.7346 | 30432.5 | 10.6942 | 0.00 | 123.55 | 0.4562 | 17.3402 | 0.00 | 1.2755 | 0.6819 | 11.3968 | 70.61 | 293.22 | 94804.9 | 524.6 | 530.6 | 3.8999 | 17084.2 | 356.73 | 1058.1 | 5091.4 | 153.40 |
| TDD219 | Unassigned | 10.0478 | 28.6591 | 0.4473 | 21.8733 | 4.9361 | 2.6844 | 3.2248 | 49.9169 | 8.5844 | 83.3219 | 10.7607 | 0.9366 | 41766.0 | 7.5179 | 0.00 | 121.46 | 0.5868 | 22.8004 | 0.00 | 1.2209 | 0.9430 | 11.8129 | 72.13 | 142.77 | 122981.5 | 465.5 | 430.1 | 4.2673 | 16952.8 | 106.50 | 905.3 | 5508.4 | 190.04 |
| TDD220 | Unassigned | 3.5637 | 15.8546 | 0.3902 | 15.7194 | 3.2319 | 2.7994 | 2.6208 | 34.0340 | 5.8069 | 38.4578 | 2.5562 | 0.6022 | 19689.6 | 13.9924 | 0.00 | 50.59 | 0.2935 | 8.6344 | 0.00 | 1.0785 | 0.4949 | 6.2476 | 42.12 | 344.51 | 32562.3 | 207.7 | 1169.3 | 3.4186 | 7549.1 | 424.25 | 1631.4 | 5706.8 | 73.53 |
| TDD221 | Unassigned | 7.2778 | 14.0945 | 0.3455 | 13.5931 | 3.0481 | 2.5856 | 2.3141 | 36.4250 | 8.7026 | 40.1753 | 3.6922 | 0.6031 | 29292.5 | 11.6739 | 0.00 | 77.04 | 0.3707 | 12.5308 | 0.00 | 1.0248 | 0.4585 | 7.1152 | 46.95 | 300.85 | 53294.6 | 299.7 | 260.8 | 2.8535 | 9747.3 | 562.27 | 1717.9 | 5933.4 | 117.12 |
| TDD222 | Unassigned | 3.6270 | 18.5799 | 0.3519 | 17.1089 | 3.6101 | 2.2119 | 2.5493 | 37.3812 | 9.2324 | 31.5960 | 2.6313 | 0.7415 | 18215.1 | 11.9716 | 0.00 | 71.56 | 0.2550 | 9.2060 | 0.00 | 0.9681 | 0.7504 | 5.8607 | 46.61 | 327.99 | 37155.8 | 283.8 | 563.8 | 3.3058 | 10559.0 | 1401.17 | 1962.4 | 5739.4 | 68.99 |
| TDD223 | Unassigned | 2.7522 | 19.6537 | 0.4367 | 17.2717 | 3.9225 | 2.5490 | 2.9033 | 41.1249 | 14.6125 | 36.5419 | 3.3315 | 0.7635 | 21488.9 | 13.5597 | 0.00 | 75.32 | 0.2801 | 10.7148 | 0.00 | 1.1697 | 0.7481 | 6.6126 | 54.50 | 323.43 | 46086.2 | 378.5 | 778.7 | 3.7962 | 8576.6 | 1079.82 | 1899.0 | 5907.3 | 85.59 |
| TDD224 | Unassigned | 46.6757 | 13.6071 | 0.4038 | 13.0859 | 3.7385 | 3.9702 | 2.1930 | 90.9619 | 152.0841 | 90.6999 | 4.3907 | 0.7449 | 153738.1 | 8.3323 | 0.00 | 67.53 | 1.9731 | 18.7986 | 0.00 | 0.9037 | 0.5355 | 9.8517 | 62.50 | 178.38 | 76444.4 | 328.4 | 0.0 | 2.7376 | 3650.7 | 3457.54 | 1054.4 | 3456.4 | 344.95 |
| TDD225 | Unassigned | 7.2799 | 16.4820 | 0.4020 | 14.8046 | 3.6336 | 3.1141 | 2.6557 | 48.0149 | 9.9196 | 47.4042 | 4.1378 | 0.7132 | 29072.4 | 12.6292 | 0.00 | 87.58 | 0.3579 | 13.6697 | 0.00 | 1.1711 | 0.5297 | 7.6258 | 63.45 | 312.52 | 50635.6 | 307.9 | 555.3 | 3.1086 | 8844.0 | 671.16 | 1748.4 | 6346.5 | 110.34 |
| TDD226 | Unassigned | 3.9139 | 27.1098 | 0.4355 | 25.0675 | 4.8429 | 3.7952 | 3.2948 | 50.8023 | 8.4452 | 84.3418 | 10.7368 | 0.8449 | 25964.9 | 8.6337 | 0.00 | 154.67 | 0.4279 | 20.2050 | 0.00 | 1.3676 | 0.6705 | 12.4600 | 104.37 | 216.66 | 106456.9 | 589.3 | 0.0 | 3.9018 | 24368.8 | 152.04 | 1310.8 | 5377.1 | 153.99 |
| TDD227 | Unassigned | 5.8441 | 37.1280 | 0.4441 | 25.6138 | 5.4276 | 4.0626 | 3.7231 | 54.8372 | 6.0285 | 81.6111 | 9.3998 | 1.0579 | 29610.5 | 9.0780 | 0.00 | 137.66 | 0.4973 | 19.8407 | 0.00 | 1.4497 | 1.0145 | 13.7121 | 112.96 | 236.36 | 103676.4 | 582.8 | 175.9 | 4.4974 | 23286.6 | 184.01 | 1233.1 | 5552.9 | 159.22 |
| TDD228 | Unassigned | 7.6603 | 28.9413 | 0.5443 | 28.3733 | 6.3919 | 3.2084 | 3.7063 | 70.4551 | 20.8257 | 70.5876 | 8.5492 | 1.2887 | 49825.9 | 10.0971 | 0.00 | 126.61 | 0.3451 | 19.1646 | 80.37 | 1.4509 | 0.9156 | 10.8231 | 103.27 | 280.83 | 94751.5 | 524.4 | 1950.2 | 5.9244 | 19987.0 | 725.60 | 6281.4 | 6742.3 | 143.27 |
| TDD229 | Unassigned | 3.8255 | 27.5465 | 0.4553 | 27.2268 | 5.8847 | 2.9128 | 3.6356 | 52.2184 | 9.9455 | 63.5397 | 8.5565 | 1.1247 | 43066.6 | 9.7834 | 0.00 | 122.87 | 0.2862 | 16.8963 | 45.21 | 1.4680 | 1.0576 | 10.0139 | 101.08 | 253.11 | 81143.5 | 456.2 | 2000.9 | 5.0955 | 16913.6 | 368.93 | 7824.1 | 6476.2 | 124.88 |
| TDD230 | Unassigned | 4.0460 | 62.2897 | 0.5663 | 42.4165 | 9.1969 | 2.5824 | 4.7751 | 77.9586 | 4.0557 | 104.8107 | 22.7004 | 1.7368 | 15534.1 | 8.4065 | 0.00 | 238.91 | 0.1959 | 27.4483 | 0.00 | 1.6732 | 1.3865 | 20.8333 | 52.40 | 199.50 | 140770.4 | 790.9 | 1199.1 | 6.8377 | 29562.2 | 92.55 | 3681.4 | 6532.6 | 182.62 |
| TDD231 | Unassigned | 7.3540 | 34.7400 | 0.5641 | 35.3891 | 7.0777 | 3.7210 | 4.1886 | 69.3053 | 6.9295 | 58.9184 | 6.5559 | 1.3811 | 34786.4 | 11.1698 | 0.00 | 118.41 | 0.2972 | 16.3227 | 79.49 | 1.3696 | 1.0364 | 10.8783 | 81.80 | 303.91 | 76650.1 | 555.8 | 871.6 | 6.1311 | 18491.2 | 405.60 | 7530.6 | 5846.7 | 116.79 |
| TDD232 | Unassigned | 7.2922 | 45.9392 | 0.5548 | 46.1116 | 8.8584 | 3.3443 | 4.1671 | 89.5206 | 14.6472 | 90.7272 | 12.2197 | 1.7609 | 49448.2 | 5.8185 | 0.00 | 187.54 | 0.4540 | 26.6585 | 0.00 | 1.1831 | 1.0703 | 15.6441 | 136.05 | 125.96 | 132138.6 | 707.7 | 2438.2 | 6.8131 | 24397.4 | 625.60 | 4271.2 | 6145.2 | 201.48 |
| TDD234 | Unassigned | 5.2431 | 20.2783 | 0.3624 | 20.2259 | 4.2458 | 2.9996 | 2.6921 | 41.5281 | 6.1794 | 43.2377 | 5.3126 | 0.8060 | 28138.2 | 10.3955 | 0.00 | 114.24 | 0.3335 | 11.1091 | 0.00 | 1.1400 | 0.8086 | 8.0068 | 62.95 | 266.18 | 64334.3 | 450.0 | 1292.2 | 3.7908 | 17817.7 | 262.15 | 6364.4 | 5137.9 | 85.10 |
| TDD235 | Unassigned | 5.1253 | 16.2443 | 0.3213 | 15.8268 | 3.4207 | 2.0252 | 2.2442 | 34.2351 | 6.0082 | 33.1560 | 3.8115 | 0.7267 | 25414.9 | 5.6610 | 0.00 | 88.53 | 0.3454 | 8.4235 | 42.91 | 0.9393 | 0.5045 | 6.4696 | 51.67 | 126.35 | 51227.0 | 339.9 | 2156.6 | 3.6334 | 14553.2 | 319.29 | 7983.8 | 3784.0 | 73.53 |
| TDD236 | Unassigned | 5.0224 | 46.6883 | 0.5743 | 40.2802 | 9.0946 | 3.4393 | 4.6613 | 93.5891 | 12.5396 | 88.1156 | 11.8073 | 1.9041 | 40239.9 | 4.9947 | 0.00 | 176.82 | 0.3739 | 27.6988 | 0.00 | 1.1605 | 1.2165 | 15.0629 | 132.70 | 122.03 | 136522.4 | 688.7 | 2533.8 | 7.8360 | 22963.6 | 358.18 | 4150.3 | 6282.0 | 192.48 |
| TDD237 | Unassigned | 7.9350 | 47.9720 | 0.5977 | 42.4601 | 9.7020 | 3.3615 | 4.5306 | 95.7722 | 14.6217 | 73.5136 | 10.5212 | 2.0692 | 35909.7 | 5.2168 | 0.00 | 146.86 | 0.3752 | 27.3727 | 0.00 | 1.1012 | 1.6754 | 14.0837 | 125.97 | 107.73 | 131318.4 | 581.1 | 3629.4 | 7.7781 | 16101.4 | 427.25 | 3222.6 | 6834.2 | 173.53 |
| TDD239 | Unassigned | 8.8603 | 29.6972 | 0.5072 | 26.3285 | 6.1373 | 3.6932 | 3.5856 | 73.5223 | 14.7971 | 63.6507 | 6.9368 | 1.1572 | 42719.3 | 10.5542 | 0.00 | 112.07 | 0.4108 | 18.9995 | 0.00 | 1.1871 | 0.7780 | 10.6087 | 72.15 | 222.56 | 81696.3 | 390.8 | 1050.9 | 4.3764 | 15738.2 | 707.79 | 4457.8 | 6247.3 | 140.95 |
| TDD240 | Unassigned | 53.0270 | 57.1180 | 0.7664 | 58.7338 | 12.4128 | 4.7289 | 6.0212 | 134.9182 | 37.0757 | 70.9222 | 10.8333 | 2.7141 | 93387.4 | 4.1551 | 0.00 | 126.97 | 0.3211 | 29.0922 | 0.00 | 1.0392 | 1.6799 | 18.6154 | 184.55 | 140.88 | 140436.8 | 0.0 | 4628.9 | 2.9196 | 10194.9 | 5186.72 | 3087.3 | 0.0 | 172.97 |

| anid | Chemical Group | As | La | Lu | Nd | Sm | U | Yb | Ce | Co | Cr | Cs | Eu | Fe | Hf |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TDD241 | Unassigned | 9.7310 | 72.5534 | 0.7693 | 63.3935 | 12.9697 | 4.4788 | 5.5324 | 141.3658 | 19.6133 | 58.1669 | 8.2540 | 2.8264 | 44725.3 | 7.0847 |
| TDD243 | Unassigned | 5.5200 | 59.2711 | 0.6611 | 50.4124 | 11.7183 | 4.0102 | 5.0187 | 118.4077 | 18.6716 | 83.5305 | 11.6272 | 2.4817 | 60954.9 | 3.4528 |
| TDD244 | Unassigned | 4.5226 | 21.3891 | 0.4878 | 21.6677 | 5.2175 | 2.6260 | 3.4473 | 45.6644 | 11.2173 | 48.0372 | 3.2782 | 1.1129 | 33472.7 | 11.2057 |
| TDD245 | Unassigned | 6.3281 | 25.2691 | 0.4969 | 27.1063 | 5.5662 | 3.0126 | 3.4362 | 54.0101 | 4.2246 | 51.4163 | 4.5325 | 1.1437 | 30394.2 | 10.3225 |
| TDD246 | Unassigned | 2.4869 | 25.8775 | 0.5295 | 24.5401 | 5.6154 | 2.5772 | 3.6505 | 51.9772 | 3.8778 | 48.2384 | 3.1336 | 1.1666 | 16498.7 | 9.9531 |
| TDD247 | Unassigned | 1.9546 | 35.8793 | 0.4688 | 32.5508 | 6.7380 | 2.9069 | 3.6756 | 73.7746 | 6.4720 | 89.1771 | 3.5966 | 1.4993 | 25081.6 | 10.4664 |
| TDD248 | Unassigned | 7.2894 | 63.9612 | 0.5653 | 56.4711 | 11.2327 | 2.5697 | 4.9086 | 102.8898 | 5.1466 | 106.1037 | 20.6976 | 2.0406 | 20713.8 | 5.9629 |
| TDD249 | Unassigned | 6.8872 | 56.4608 | 0.5932 | 49.1383 | 10.7855 | 4.7313 | 5.1040 | 82.6588 | 13.1694 | 91.9855 | 12.1187 | 2.0272 | 50068.1 | 7.1879 |
| TDD250 | Unassigned | 9.0514 | 21.3788 | 0.4382 | 22.5829 | 4.7729 | 1.5396 | 3.0176 | 47.1092 | 10.5197 | 39.2553 | 3.8427 | 1.0132 | 36484.2 | 10.9950 |
| TDD251 | Unassigned | 10.1999 | 21.0739 | 0.4628 | 22.4331 | 5.6309 | 3.3203 | 3.2078 | 61.2965 | 17.0597 | 54.6248 | 5.4583 | 1.2600 | 61158.5 | 8.7442 |
| TDD252 | Unassigned | 4.8555 | 27.0530 | 0.5363 | 24.4669 | 5.7572 | 3.1798 | 3.7682 | 56.3824 | 8.1083 | 41.2346 | 3.8539 | 1.1430 | 23751.4 | 11.9840 |
| TDD253 | Unassigned | 5.6012 | 20.5566 | 0.4254 | 21.4936 | 4.1804 | 3.4390 | 3.1321 | 40.9588 | 4.6478 | 48.3081 | 5.5744 | 0.8401 | 39925.6 | 11.3390 |
| TDD254 | Unassigned | 18.1197 | 58.6333 | 0.6511 | 57.2541 | 10.5820 | 5.1114 | 4.8482 | 94.4809 | 10.7512 | 107.4169 | 16.1184 | 1.9180 | 46440.0 | 6.6997 |
| TDD255 | Unassigned | 2.6404 | 29.7430 | 0.4408 | 24.4808 | 5.1544 | 3.8200 | 3.2672 | 60.0787 | 7.9888 | 77.5442 | 8.9623 | 0.8999 | 27621.9 | 9.9671 |
| TDD256 | Unassigned | 2.9327 | 16.9876 | 0.4354 | 14.7585 | 3.6264 | 2.9873 | 3.1511 | 35.5268 | 6.5065 | 34.8633 | 2.8854 | 0.6953 | 20107.0 | 15.2394 |
| TDD257 | Unassigned | 7.8500 | 34.3557 | 0.5824 | 39.6803 | 7.8421 | 2.9468 | 4.6650 | 94.9271 | 15.7110 | 62.7412 | 8.3746 | 1.6176 | 43720.6 | 9.6915 |
| TDD258 | Unassigned | 4.2857 | 25.0842 | 0.5039 | 21.1916 | 5.1930 | 3.5172 | 3.7757 | 48.7928 | 10.7196 | 40.9672 | 3.4921 | 1.0841 | 29929.8 | 12.5899 |
| TDD259 | Unassigned | 5.9900 | 31.5061 | 0.5942 | 33.8031 | 7.1421 | 3.2497 | 4.0619 | 57.2676 | 12.9534 | 44.5206 | 4.3323 | 1.5772 | 35730.0 | 13.0956 |
| TDD261 | Unassigned | 2.1824 | 28.7709 | 0.2600 | 23.5872 | 4.8290 | 3.7654 | 1.8183 | 53.9247 | 8.4279 | 33.4898 | 3.6172 | 1.3901 | 39869.5 | 8.0664 |
| TDD266 | Unassigned | 8.5353 | 29.8151 | 0.5169 | 29.8173 | 6.2196 | 2.7383 | 3.3563 | 86.4278 | 14.1625 | 68.7868 | 7.7872 | 1.3212 | 57397.8 | 11.6818 |
| TDD277 | Unassigned | 7.9983 | 26.6880 | 0.2881 | 26.4237 | 5.4384 | 1.4041 | 2.2345 | 65.3503 | 14.1775 | 27.4804 | 6.4949 | 1.2052 | 44290.7 | 5.6640 |
| TDD280 | Unassigned | 3.0228 | 22.9399 | 0.4223 | 27.7583 | 5.9489 | 1.9505 | 3.0207 | 45.9859 | 13.1060 | 28.5782 | 3.6019 | 1.4461 | 43072.7 | 10.0934 |
| TDD281 | Unassigned | 4.7064 | 21.4077 | 0.5753 | 29.7459 | 7.6181 | 5.9165 | 4.2626 | 52.4406 | 8.0968 | 25.2831 | 2.0183 | 2.0207 | 35495.5 | 10.9164 |
| TDD283 | Unassigned | 2.6868 | 24.1680 | 0.4495 | 26.7577 | 6.6723 | 2.5361 | 3.3410 | 54.3446 | 12.5627 | 24.8677 | 3.4624 | 1.6248 | 42168.6 | 10.4133 |
| TDD284 | Unassigned | 3.2016 | 14.7733 | 0.2840 | 18.4240 | 4.2493 | 1.1439 | 2.0208 | 44.5578 | 16.5054 | 48.7779 | 4.4966 | 0.9738 | 43132.9 | 5.7213 |
| TDD285 | Unassigned | 2.6130 | 46.2572 | 0.2876 | 29.3688 | 5.5607 | 2.1677 | 2.3601 | 75.8012 | 6.3461 | 14.5202 | 3.8428 | 1.7244 | 28804.6 | 10.1747 |
| TDD288 | Unassigned | 8.5320 | 17.4204 | 0.3973 | 18.1928 | 4.0540 | 1.4075 | 2.9988 | 44.5478 | 19.1694 | 35.4040 | 2.5161 | 0.9000 | 41854.2 | 9.7294 |
| TDD294 | Unassigned | 3.4818 | 38.9599 | 0.3120 | 29.5425 | 5.6125 | 1.4757 | 2.2726 | 83.8660 | 7.5457 | 24.7365 | 3.4275 | 1.3628 | 31713.0 | 8.3782 |
| TDD295 | Unassigned | 3.8519 | 28.2751 | 0.3428 | 30.0310 | 5.7056 | 1.9820 | 2.5204 | 58.2321 | 11.1564 | 24.6924 | 4.8289 | 1.2346 | 38702.9 | 5.1719 |
| TDD313 | Unassigned | 15.5014 | 15.4665 | 0.3657 | 14.6393 | 3.9496 | 2.1674 | 2.5394 | 169.5923 | 51.2732 | 51.2820 | 4.3177 | 0.8206 | 49124.0 | 9.6696 |
| TDD316 | Unassigned | 6.2250 | 23.1438 | 0.3398 | 23.6397 | 5.1321 | 2.2599 | 2.2567 | 58.1679 | 55.7945 | 41.6774 | 5.1181 | 1.1232 | 64063.3 | 5.7396 |
| TDD323 | Unassigned | 8.4450 | 55.3048 | 0.5403 | 48.1359 | 9.7086 | 3.2360 | 4.3318 | 135.3807 | 31.0997 | 79.4078 | 10.2351 | 1.9796 | 49560.1 | 7.1430 |
| TDD324 | Unassigned | 8.3056 | 28.6244 | 0.5254 | 30.0528 | 6.3271 | 2.3449 | 3.5913 | 68.3107 | 11.8687 | 33.3727 | 3.4754 | 1.3364 | 36153.6 | 11.0318 |
| TDD325 | Unassigned | 11.3725 | 18.4721 | 0.3833 | 17.9413 | 4.1714 | 2.3996 | 2.6217 | 60.9376 | 28.8023 | 45.2815 | 4.7482 | 0.8440 | 56262.0 | 10.7930 |
| TDD327 | Unassigned | 9.6078 | 28.4256 | 0.4026 | 25.3715 | 5.4749 | 2.0729 | 2.8912 | 60.1355 | 6.5306 | 45.2138 | 4.8931 | 1.2308 | 47947.0 | 7.9160 |
| TDD328 | Unassigned | 4.2089 | 20.7340 | 0.3750 | 19.6512 | 4.2263 | 1.9116 | 2.5443 | 47.1618 | 6.6906 | 35.2474 | 3.3125 | 0.9751 | 24544.2 | 9.0681 |
| TDD329 | Unassigned | 6.1519 | 21.5306 | 0.4555 | 21.0375 | 4.6258 | 1.9689 | 3.1509 | 48.7039 | 8.8251 | 46.8504 | 3.4559 | 1.0187 | 32109.1 | 10.2893 |
| TDD330 | Unassigned | 42.8400 | 21.8570 | 0.5435 | 20.0000 | 4.9071 | 3.4843 | 3.9467 | 95.9873 | 75.5470 | 76.3291 | 4.2641 | 1.1031 | 160596.9 | 7.2018 |
| TDD331 | Unassigned | 6.6968 | 29.9049 | 0.5516 | 30.1486 | 6.5660 | 2.6429 | 3.7972 | 61.4436 | 9.3391 | 61.0327 | 5.6964 | 1.4132 | 39943.7 | 9.9697 |
| TDD332 | Unassigned | 8.0713 | 19.4059 | 0.3946 | 18.5950 | 3.7731 | 2.8353 | 2.8109 | 41.2111 | 37.0759 | 62.4550 | 7.0533 | 0.7425 | 40742.7 | 9.9047 |
| TDD334 | Unassigned | 5.1658 | 28.8708 | 0.5678 | 33.7648 | 8.0919 | 0.9783 | 4.4443 | 53.5451 | 14.1376 | 42.7543 | 6.1553 | 2.2315 | 54653.5 | 5.1635 |
| TDD336 | Unassigned | 3.5414 | 10.1932 | 0.5407 | 14.4012 | 4.6863 | 1.2764 | 4.1900 | 24.0361 | 34.6031 | 144.1922 | 1.7693 | 1.5070 | 89278.1 | 4.9779 |
| TDD339 | Unassigned | 8.6989 | 18.8443 | 0.4606 | 21.5594 | 5.1066 | 1.9902 | 3.3567 | 79.5145 | 15.6672 | 46.2756 | 3.7642 | 1.1730 | 46547.3 | 9.9031 |
| TDD343 | Unassigned | 3.5789 | 33.6544 | 0.6432 | 42.2330 | 9.5393 | 1.3062 | 4.8277 | 63.1440 | 12.4003 | 44.8982 | 6.6008 | 2.4821 | 48969.6 | 5.6321 |
| TDD344 | Unassigned | 0.0000 | 23.9729 | 0.5433 | 28.8963 | 7.1425 | 2.1380 | 4.0146 | 51.0284 | 12.9507 | 41.2549 | 5.1019 | 1.8588 | 46954.8 | 4.5109 |
| TDD348 | Unassigned | 3.5132 | 33.4997 | 0.3865 | 33.4821 | 6.4742 | 3.1310 | 2.9102 | 66.5233 | 4.0857 | 54.9264 | 5.6532 | 1.0029 | 20129.5 | 9.6549 |
| TDD351 | Unassigned | 5.2510 | 22.1247 | 0.3509 | 19.2300 | 4.3655 | 2.4268 | 2.3048 | 46.5359 | 11.7315 | 46.0292 | 5.0526 | 0.8967 | 38433.3 | 7.2071 |
| TDD353 | Unassigned | 10.1123 | 19.6737 | 0.2188 | 23.8489 | 4.2454 | 2.3808 | 1.3779 | 47.2480 | 12.2383 | 34.6194 | 5.5192 | 1.0206 | 42467.8 | 4.6182 |
| TDD354 | Unassigned | 9.5049 | 46.7951 | 0.5200 | 47.0209 | 8.9432 | 4.4063 | 4.1115 | 96.7463 | 17.7840 | 98.7181 | 11.3975 | 1.7652 | 52323.2 | 7.7791 |
| TDD359 | Unassigned | 3.8591 | 43.9305 | 0.5245 | 42.5023 | 9.0582 | 4.4529 | 3.7919 | 91.9010 | 17.3519 | 75.7309 | 10.0818 | 1.8083 | 43916.5 | 8.1761 |
| TDD360 | Unassigned | 3.0876 | 34.7730 | 0.4829 | 34.1179 | 6.9574 | 3.3416 | 3.3482 | 66.9594 | 6.1641 | 15.4677 | 6.5249 | 1.1993 | 25909.1 | 5.3124 |

| anid | Ni | Rb | Sb | Sc | Sr | Ta | Tb | Th | Zn | Zr | Al | Ba | Ca | Dy | K | Mn | Na | Ti | V |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TDD241 | 44.23 | 117.30 | 0.3226 | 25.4816 | 72.35 | 1.1203 | 1.6678 | 14.3538 | 114.00 | 163.01 | 131133.6 | 545.4 | 10194.7 | 9.5763 | 14334.7 | 1267.76 | 6698.5 | 6180.8 | 241.16 |
| TDD243 | 0.00 | 198.19 | 0.3662 | 32.1868 | 0.00 | 1.0207 | 1.9077 | 16.6449 | 155.13 | 122.46 | 140139.6 | 636.5 | 5683.9 | 9.3244 | 19615.5 | 885.65 | 2740.6 | 7141.4 | 216.50 |
| TDD244 | 0.00 | 57.19 | 0.3153 | 15.2847 | 0.00 | 0.9880 | 0.7240 | 6.7958 | 55.49 | 242.93 | 55682.6 | 191.2 | 1284.1 | 4.2743 | 5822.7 | 724.91 | 2411.3 | 6313.4 | 100.59 |
| TDD245 | 0.00 | 75.80 | 0.3781 | 12.5779 | 0.00 | 1.2059 | 0.8208 | 8.7710 | 53.64 | 229.40 | 57549.7 | 353.6 | 1144.3 | 5.1001 | 11151.9 | 313.76 | 6202.7 | 6022.7 | 105.96 |
| TDD246 | 22.38 | 56.24 | 0.2550 | 11.2530 | 0.00 | 0.9995 | 0.8372 | 7.4741 | 41.86 | 241.49 | 46745.0 | 285.0 | 1365.7 | 4.8318 | 9878.9 | 272.91 | 4791.3 | 6271.0 | 93.23 |
| TDD247 | 0.00 | 78.04 | 0.2945 | 13.7170 | 151.32 | 1.1116 | 0.8894 | 9.5600 | 51.86 | 265.79 | 82200.1 | 534.7 | 8882.2 | 4.7585 | 14747.8 | 253.27 | 8960.1 | 7176.2 | 94.74 |
| TDD248 | 0.00 | 215.42 | 1.0210 | 27.7030 | 0.00 | 1.4947 | 1.5106 | 19.7745 | 0.00 | 115.17 | 153349.2 | 790.9 | 2197.9 | 8.0839 | 32652.5 | 115.53 | 2198.0 | 5450.7 | 201.93 |
| TDD249 | 0.00 | 168.25 | 0.4748 | 23.8016 | 0.00 | 1.1832 | 1.4562 | 15.9727 | 99.14 | 174.76 | 120091.3 | 717.4 | 2172.0 | 7.9638 | 21938.2 | 423.24 | 3297.5 | 5786.8 | 185.95 |
| TDD250 | 0.00 | 80.41 | 0.3516 | 15.3153 | 0.00 | 1.0111 | 0.6903 | 7.9434 | 57.40 | 251.21 | 68727.9 | 316.6 | 1239.4 | 3.9615 | 7537.2 | 722.26 | 3061.1 | 6476.3 | 120.98 |
| TDD251 | 0.00 | 91.11 | 0.5701 | 22.9393 | 0.00 | 0.8919 | 0.6861 | 9.0048 | 147.94 | 199.34 | 107629.7 | 304.0 | 258.5 | 4.4169 | 8385.1 | 794.48 | 1955.1 | 6552.9 | 178.06 |
| TDD252 | 0.00 | 80.73 | 0.3261 | 11.7563 | 87.18 | 1.1859 | 0.7663 | 8.2212 | 64.88 | 268.21 | 55265.2 | 287.1 | 3309.4 | 4.7185 | 11099.2 | 610.55 | 9697.9 | 5697.7 | 83.03 |
| TDD253 | 0.00 | 85.04 | 0.3098 | 15.3597 | 0.00 | 1.1471 | 0.5066 | 7.4837 | 57.52 | 241.67 | 74195.6 | 346.1 | 499.1 | 3.5987 | 12186.3 | 192.14 | 2692.6 | 7005.2 | 121.84 |
| TDD254 | 0.00 | 183.38 | 0.8386 | 27.1590 | 34.75 | 1.2193 | 1.6559 | 26.6927 | 115.88 | 166.10 | 144091.1 | 701.7 | 1530.0 | 7.8412 | 28882.8 | 205.72 | 4580.7 | 4852.5 | 203.04 |
| TDD255 | 0.00 | 121.33 | 0.3878 | 18.5419 | 0.00 | 1.4474 | 0.6135 | 13.9087 | 89.29 | 226.60 | 100716.6 | 528.6 | 256.0 | 4.3622 | 20648.8 | 168.88 | 911.5 | 6367.1 | 156.56 |
| TDD256 | 0.00 | 62.66 | 0.3042 | 9.8622 | 0.00 | 1.1562 | 0.5857 | 6.6773 | 41.42 | 349.16 | 38467.6 | 279.0 | 968.2 | 3.3168 | 9646.0 | 725.01 | 2178.5 | 5964.7 | 88.48 |
| TDD257 | 0.00 | 116.22 | 0.4912 | 22.9221 | 0.00 | 1.2099 | 1.4389 | 10.3050 | 90.00 | 202.03 | 96664.0 | 461.5 | 2908.2 | 6.4542 | 14540.4 | 1024.76 | 1333.6 | 6542.4 | 176.18 |
| TDD258 | 0.00 | 63.13 | 0.3478 | 13.6848 | 0.00 | 1.0654 | 0.8489 | 6.9521 | 58.00 | 290.61 | 48469.0 | 233.0 | 1041.1 | 4.4974 | 6859.0 | 1042.69 | 1675.7 | 5657.3 | 95.15 |
| TDD259 | 0.00 | 67.58 | 0.4017 | 17.8071 | 0.00 | 1.0866 | 1.1042 | 7.5655 | 67.93 | 333.48 | 62621.1 | 231.4 | 0.0 | 5.9913 | 6572.4 | 970.35 | 1367.3 | 7182.1 | 137.70 |
| TDD261 | 0.00 | 77.98 | 0.1627 | 15.0050 | 149.57 | 0.8173 | 0.6938 | 12.6551 | 59.77 | 199.75 | 101181.7 | 497.8 | 14333.9 | 3.5075 | 12769.3 | 295.88 | 9949.7 | 4794.3 | 112.07 |
| TDD266 | 54.23 | 95.29 | 0.4905 | 24.4886 | 0.00 | 1.1934 | 0.8712 | 11.8395 | 96.27 | 245.29 | 100006.4 | 218.2 | 1542.4 | 5.3443 | 9263.0 | 1331.95 | 1249.6 | 9021.9 | 163.94 |
| TDD277 | 0.00 | 112.42 | 0.3502 | 17.2276 | 160.33 | 0.8150 | 0.7081 | 11.1384 | 86.18 | 111.97 | 108114.9 | 642.5 | 25072.1 | 3.9785 | 15521.3 | 430.96 | 15605.2 | 3537.0 | 87.86 |
| TDD280 | 0.00 | 103.28 | 0.2053 | 22.3774 | 125.11 | 0.6584 | 0.7935 | 10.4441 | 80.97 | 247.76 | 93006.8 | 782.7 | 18454.4 | 7.0423 | 15190.0 | 258.37 | 11353.7 | 7703.9 | 141.90 |
| TDD281 | 32.93 | 71.06 | 0.2416 | 22.2753 | 194.29 | 3.8871 | 1.2688 | 16.0140 | 46.99 | 255.02 | 101903.2 | 635.3 | 21659.1 | 5.3619 | 21363.0 | 686.95 | 12713.3 | 3717.0 | 74.66 |
| TDD283 | 0.00 | 91.48 | 0.2265 | 21.1791 | 132.95 | 1.5134 | 1.1886 | 10.1915 | 79.54 | 247.10 | 88692.9 | 499.2 | 19811.7 | 3.9312 | 12074.4 | 987.75 | 10879.9 | 4136.6 | 139.83 |
| TDD284 | 0.00 | 77.08 | 0.2150 | 21.5094 | 166.29 | 0.5958 | 0.5494 | 8.3844 | 68.43 | 134.41 | 105787.4 | 667.6 | 21941.6 | 4.7308 | 14558.2 | 566.89 | 12943.0 | 4667.2 | 92.67 |
| TDD285 | 0.00 | 97.09 | 0.1988 | 14.1448 | 240.20 | 0.4455 | 0.7724 | 12.9561 | 56.17 | 254.42 | 109231.1 | 556.4 | 13289.9 | 3.7340 | 17868.5 | 219.31 | 22430.5 | 3422.8 | 81.96 |
| TDD288 | 0.00 | 62.29 | 0.3646 | 15.4949 | 0.00 | 0.7557 | 0.6503 | 6.7645 | 57.74 | 219.94 | 65569.9 | 466.8 | 3517.8 | 3.8861 | 7365.2 | 1547.50 | 2779.8 | 6372.2 | 130.86 |
| TDD294 | 0.00 | 96.04 | 0.1267 | 17.7679 | 166.38 | 0.6795 | 0.9033 | 13.3554 | 78.08 | 187.14 | 108730.9 | 601.1 | 17352.8 | 4.0628 | 15721.8 | 340.74 | 14196.8 | 5441.3 | 91.12 |
| TDD295 | 0.00 | 99.10 | 0.2220 | 17.0258 | 144.07 | 0.7452 | 0.8592 | 10.7764 | 72.90 | 118.96 | 90963.4 | 516.8 | 10692.6 | 4.1359 | 18767.8 | 436.55 | 16570.0 | 3624.0 | 118.51 |
| TDD313 | 0.00 | 75.94 | 0.4836 | 16.4871 | 0.00 | 1.0703 | 0.6076 | 9.4598 | 67.67 | 241.96 | 78526.8 | 486.0 | 1845.3 | 3.1396 | 8730.1 | 1359.76 | 4590.3 | 5045.7 | 179.82 |
| TDD316 | 0.00 | 64.44 | 0.1972 | 20.4676 | 119.82 | 0.6969 | 0.6955 | 9.4591 | 71.46 | 164.67 | 87257.0 | 340.1 | 18441.1 | 2.6316 | 11504.6 | 2542.87 | 9371.7 | 4588.4 | 122.87 |
| TDD323 | 0.00 | 138.18 | 0.4812 | 21.8355 | 71.42 | 1.1153 | 1.3150 | 19.6333 | 102.04 | 206.43 | 113229.8 | 543.1 | 507.4 | 7.6300 | 20452.7 | 618.93 | 6017.6 | 5537.8 | 172.29 |
| TDD324 | 0.00 | 66.77 | 0.2769 | 11.8141 | 0.00 | 0.9172 | 0.9396 | 7.6933 | 45.39 | 261.49 | 53008.9 | 371.6 | 3171.5 | 5.1172 | 10729.5 | 824.19 | 4274.2 | 5236.1 | 110.18 |
| TDD325 | 0.00 | 66.72 | 0.4971 | 17.4798 | 0.00 | 0.9338 | 0.5786 | 8.9224 | 61.69 | 281.60 | 89449.1 | 236.9 | 1023.6 | 3.3712 | 7209.3 | 1465.22 | 1387.9 | 7354.7 | 174.08 |
| TDD327 | 0.00 | 80.48 | 0.4315 | 21.2468 | 0.00 | 0.9215 | 0.9151 | 8.4644 | 87.36 | 186.43 | 97673.8 | 285.1 | 805.4 | 4.6541 | 9727.9 | 448.73 | 1283.6 | 6885.7 | 153.34 |
| TDD328 | 0.00 | 61.76 | 0.2731 | 13.3155 | 0.00 | 0.8477 | 0.6802 | 5.9859 | 52.57 | 249.25 | 52181.0 | 168.8 | 498.9 | 3.6431 | 6547.0 | 526.42 | 1522.2 | 5379.6 | 87.86 |
| TDD329 | 0.00 | 68.02 | 0.3708 | 12.7688 | 22.79 | 1.0565 | 0.6512 | 6.8224 | 55.24 | 238.43 | 49863.0 | 193.9 | 981.9 | 4.2842 | 8140.0 | 480.63 | 3417.1 | 6178.9 | 104.58 |
| TDD330 | 0.00 | 85.39 | 1.4966 | 15.4867 | 0.00 | 0.7767 | 0.6880 | 7.5957 | 81.79 | 141.90 | 59561.3 | 453.0 | 0.0 | 2.4184 | 2923.4 | 5966.07 | 1179.0 | 1820.0 | 366.40 |
| TDD331 | 35.31 | 107.88 | 0.3464 | 16.0516 | 0.00 | 1.0509 | 0.8807 | 9.8034 | 63.88 | 245.07 | 69660.7 | 468.4 | 2740.1 | 5.8731 | 14121.6 | 711.33 | 5722.8 | 5938.0 | 128.23 |
| TDD332 | 0.00 | 110.41 | 0.4428 | 16.9293 | 0.00 | 1.1312 | 0.5117 | 10.3521 | 57.30 | 211.95 | 77090.9 | 379.9 | 186.0 | 3.2366 | 12494.7 | 561.17 | 1481.5 | 5489.0 | 147.05 |
| TDD334 | 0.00 | 128.44 | 0.6972 | 25.8421 | 255.61 | 0.2596 | 1.1593 | 3.8100 | 125.60 | 100.16 | 107840.2 | 728.7 | 22882.0 | 7.2435 | 25651.3 | 579.27 | 10678.9 | 7101.8 | 179.94 |
| TDD336 | 0.00 | 25.38 | 0.3042 | 43.0943 | 135.72 | 0.3955 | 0.9174 | 2.4577 | 107.83 | 121.88 | 87408.3 | 324.9 | 37574.6 | 6.3533 | 5512.2 | 1011.45 | 14868.8 | 10584.3 | 352.33 |
| TDD339 | 28.83 | 66.87 | 0.3483 | 17.3608 | 81.97 | 0.8355 | 0.7594 | 8.0336 | 73.02 | 213.64 | 83463.8 | 831.9 | 3952.5 | 4.3916 | 7650.7 | 544.57 | 3514.4 | 5050.3 | 146.51 |
| TDD343 | 0.00 | 127.74 | 0.6054 | 28.0309 | 194.93 | 0.4586 | 1.7169 | 5.1685 | 112.76 | 142.86 | 108752.6 | 732.4 | 16479.4 | 8.3391 | 22777.3 | 522.71 | 8430.1 | 6752.8 | 198.98 |
| TDD344 | 0.00 | 101.31 | 0.3868 | 21.8627 | 215.07 | 0.4156 | 1.1730 | 4.5151 | 99.05 | 127.38 | 101340.0 | 491.8 | 21128.9 | 7.5408 | 15458.5 | 613.78 | 15062.0 | 5710.6 | 157.18 |
| TDD348 | 0.00 | 114.10 | 0.1968 | 15.8967 | 120.60 | 1.0371 | 0.7768 | 14.0464 | 69.00 | 229.23 | 84441.0 | 1433.6 | 5270.1 | 4.5755 | 19818.5 | 240.48 | 5983.0 | 4785.1 | 98.98 |
| TDD351 | 0.00 | 88.92 | 0.2802 | 15.1301 | 95.38 | 1.1508 | 0.5800 | 8.1757 | 68.01 | 160.45 | 78621.3 | 536.8 | 3975.2 | 3.0610 | 16494.2 | 756.07 | 6508.5 | 5820.5 | 105.13 |
| TDD353 | 0.00 | 62.62 | 0.3168 | 18.3170 | 112.86 | 0.6980 | 0.3990 | 9.4553 | 73.78 | 97.12 | 99295.6 | 482.3 | 6576.9 | 2.9972 | 8446.9 | 302.38 | 3501.4 | 5191.5 | 161.34 |
| TDD354 | 51.42 | 164.99 | 0.3042 | 24.9285 | 0.00 | 1.2155 | 1.2070 | 17.3888 | 143.13 | 164.52 | 136448.3 | 806.3 | 5084.1 | 7.2370 | 23705.3 | 495.21 | 6580.0 | 6067.3 | 170.20 |
| TDD359 | 0.00 | 182.44 | 0.8207 | 24.0264 | 141.51 | 1.4120 | 1.1288 | 13.1893 | 119.80 | 179.35 | 113875.4 | 535.3 | 7835.2 | 7.9440 | 26154.4 | 633.92 | 8467.5 | 5863.0 | 170.54 |
| TDD360 | 0.00 | 177.39 | 0.1137 | 14.4262 | 198.15 | 0.8865 | 0.9390 | 12.0441 | 59.18 | 133.67 | 77059.8 | 973.4 | 79326.2 | 5.7616 | 23820.3 | 1232.03 | 8327.5 | 3671.5 | 162.92 |

## Appendix IV, Table 3: Details of the Petrographic Analysis.

| Sample | TDD9 | TDD10 | TDD11 | TDD15 | TDD2 | TDD5 | TDD7 | TDD13 | TDD16 | TDD18 |
|---|---|---|---|---|---|---|---|---|---|---|
| Mineral group | 1A | 1A | 1A | 1A | 1A | 1A | 1A | 1A | 1A | 1A |
| type of temper | Sand | sand | sand | sand | regolith | regolith | regolith | regolith | regolith | regolith |
| | | | | | | | | | | |
| percent temper | 60-70 | 50-60 | 60-70 | 50-60 | 60-70 | 30-40 | 50-60 | 40-50 | 60-70 | 30-40 |
| Length min (mm) | 0.1 | 0.1 | 0.1 | 0.1 | 0.05 | 0.1 | 0.05 | 0.1 | 0.1 | 0.1 |
| Length max (mm) | 1 | 0.8 | 1.8 | 2 | 0.8 | 0.8 | 1 | 1.5 | 3 | 0.5 |
| Modal length (mm) | 0.3 | 0.3 | 0.5 | 0.5 | 0.4 | 0.5 | 0.3 | 0.3 | 0.4 | 0.3 |
| component 1 | plagioclase | plagioclase | plagioclase | quartz | quartz | Quartz | quartz | quartz | quartz | quartz |
| component 2 | Quartz | quartz | quartz | plagioclase | K-feldspar | K-feldspar | K-feldspar | plagioclase | Plagioclase | plagioclase |
| component 3 | amphibole | K-feldspar | K-feldspar | granite | plagioclase | plagioclase | plagioclase | K-feldspar | K-feldspar | K-feldspar |
| component 4 | K-feldspar | amphibole | amphibole | K-feldspar | Amphibole | amphibole | amphibole | amphibole | Amphibole | amphibole |
| component 5 | Granite | | | amphibole | | Chlorite | ceramic fragments | | | biotite |
| component 6 | | | | | | | | | | ceramic fragments |
| roundness | moderate to high | moderate | moderate | moderate | moderate | Moderate to low | moderate | moderate to low | moderate to low | moderate |
| Color | dark yellow brown | olive-brown | dark brown | dark red-brown | very dark red-brown | dark red-brown | yellow brown | yellow brown | dark red-brown | dark red-brown |
| Source rock | Granite | granite | granite | granite | granite | Granite | granite | granite | granite | granite |
| comments | the temper is sand no weathering | the temper is sand no weathering | the temper is sand no weathering | the temper is sand no weathering | | weathered feldspars | | weathered feldspars | weathered feldspars | weathered feldspars |

| Sample | TDD21B | TDD23a | TDD23b | TDD24 | TDD25 | TDD26 | TDD28a | TDD28b | TDD28c | TDD28d |
|---|---|---|---|---|---|---|---|---|---|---|
| Mineral group | 1A | 1A | 1A | 1A | 1A | 1A | 1A | 1A | 1A | 1A |
| Type of temper | Regolith | regolith | regolith | regolith | regolith | regolith | regolith | regolith | regolith | regolith |
| | | | | | | | | | | |
| percent temper | 40-50 | 40-50 | 50-60 | 40-50 | 40-50 | 40-50 | 50-60 | 40-50 | 30-40 | 30-40 |
| Length min (mm) | 0.1 | 0.1 | 0.05 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Length max (mm) | 2 | 1.2 | 0.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 0.8 | 0.8 |
| Modal length (mm) | 0.5 | 0.4 | 0.2 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.5 | 0.5 |
| component 1 | Quartz | quartz | quartz | quartz | quartz | quartz | quartz | quartz | quartz | quartz |
| component 2 | amphibole | plagioclase | K-feldspar | K-feldspar | K-feldspar | K-feldspar | K-feldspar | K-feldspar | K-feldspar | K-feldspar |
| component 3 | plagioclase | K-feldspar | plagioclase | plagioclase | plagioclase | plagioclase | plagioclase | plagioclase | Plagioclase | plagioclase |
| component 4 | | amphibole | amphibole | amphibole | Amphibole | amphibole | amphibole | amphibole | Amphibole | amphibole |
| component 5 | | | | | | | | | | |
| component 6 | | | | | | | | | | |
| roundness | Moderate | moderate | moderate | moderate | moderate | moderate | moderate | moderate | Moderate | moderate |
| Color | light orange brown | dark orange brown | dark red-brown | dark red-brown | dark orange brown | dark orange brown | dark orange brown | dark orange brown | brown | brown |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |
| Source rock | Granite | granite | granite | granite | granite | granite | granite | granite | granite | granite |
| comments | weathered feldspars | weathered feldspars | weathered feldspars | weathered feldspars | weathered feldspars | weathered feldspars | weathered feldspars | weathered feldspars | weathered feldspars | weathered feldspars |

| Sample | **TDD12** | **TDD17** | **TDD1** | **TDD3** | **TDD22** | **TDD6** | **TDD8** | **TDD21A** | **TDD29** | **TDD30** |
|---|---|---|---|---|---|---|---|---|---|---|
| Mineral group | 1B | 1B | 1C | 1C | 1D | 1E | 1E | 1E | 1E | 1E |
| type of temper | Regolith | regolith | regolith | regolith | regolith | regolith | regolith | regolith | regolith | regolith |
| | | | | | | | | | | |
| percent temper | 40-50 | 40-50 | 60-70 | 50-60 | 30-40 | 60-70 | 50-60 | 40-50 | 30-40 | 30-40 |
| Length min (mm) | 0.1 | 0.1 | 0.05 | 0.2 | 0.1 | 0.05 | 0.05 | 0.1 | 0.1 | 0.1 |
| Length max (mm) | 2 | 0.8 | 1 | 0.8 | 2 | 1.5 | 2 | 1.5 | 0.5 | 0.4 |
| Modal length (mm) | 0.5 | 0.3 | 0.2 | 0.4 | 0.3 | 0.4 | 0.4 | 0.5 | 0.3 | 0.2 |
| component 1 | Quartz | quartz | quartz | quartz | quartz | quartz | K-feldspar | quartz | quartz | quartz |
| component 2 | feld potasico | plagioclase | K-feldspar | K-feldspar | plagioclase | K-feldspar | plagioclase | plagioclase | K-feldspar | K-feldspar |
| component 3 | Biotite | biotite | plagioclase | plagioclase | K-feldspar | plagioclase | quartz | K-feldspar | Plagioclase | |
| component 4 | | K-feldspar | epidote | epidote | biotite | | | epidote | | |
| component 5 | | | | | epidote | | | | | |
| component 6 | | | | | | | | | | |
| roundness | Moderate | moderate to low | moderate | moderate to high | moderate to low | moderate | moderate | moderate to low | moderate to low | Moderate |
| Color | dark red-brown | dark yellow brown | yellow brown | vey dark red-brown | yellow brown | very dark red-brown | light yellow brown | dark orange brown | very dark brown | very light brown |
| Source rock | Syenite | granite | granite | granite | granite | syenite | syenite | granite | syenite | Syenite |
| comments | weathered feldspars | weathered feldspars dark redish brown slips | weathered feldspars | weathered feldspars very similar to TDD2 | weathered feldspars | weathered feldspars | weathered feldspars | weathered feldspars | weathered feldspars | paint in one boder |

| Sample | **TDD14** | **TDD4** | **TDD19** | **TDD27** | **TTD172** | **TTD173** | **TTD174** | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| mineralogic group | 2 | 3 | 3 | 3 | 1B + 3 | 3 + VOLC | 1B +3 | | | |
| type of temper | crushed | regolith | regolith | regolith | regolith | crushed | crushed | | | |
| | | | | | | | | | | |
| percent temper | 50-60 | 20-30 | 70-80 | 30-40 | 50-60 | 20-30 | 20-30 | | | |
| Length min (mm) | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | | | |
| Length max (mm) | 1.8 | 0.6 | 0.5 | 0.5 | 1.2 | 1.6 | 1.6 | | | |
| Modal length (mm) | 0.4 | 0.3 | 0.3 | 0.3 | 0.4 | 0.5 | 0.5 | | | |
| component 1 | Quartz | quartz | quartz | quartz | quartz | quartz | quartz | | | |
| component 2 | ceramic fragment | muscovite | muscovite | muscovite | K-feldspar | amphibole | muscovite | | | |
| component 3 | | K-feldspar | K-feldspar | K-feldspar | muscovite | muscovite | epidote | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| component 4 | | | plagioclase | | biotite | epidote | metamorphic rock mica | | | |
| component 5 | | | amphibole | | epidote | metamorphic rock mica | granite | | | |
| component 6 | | | | | cuarcita | andesita | | | | |
| component 7 | | | | ceramic fragment | ceramic fragment | | | | | |
| roundness | moderate | moderate | moderate | moderate to low | moderate to low | malo | | | | |
| Color | yellow brown | very dark red-brown | brown | dark orange brown | orange brown | very dark red-brown | very dark red-brown | | | |
| Source rock | quartz | metamorphic rock | metamorphic rock | metamorphic rock | metamorphic rock + granite | metamorphic rock + andesite | metamorphic rock + granite | | | |
| comments | | | dark redish brown slips | | hematite fragments dark redish brown slips | | | | | |