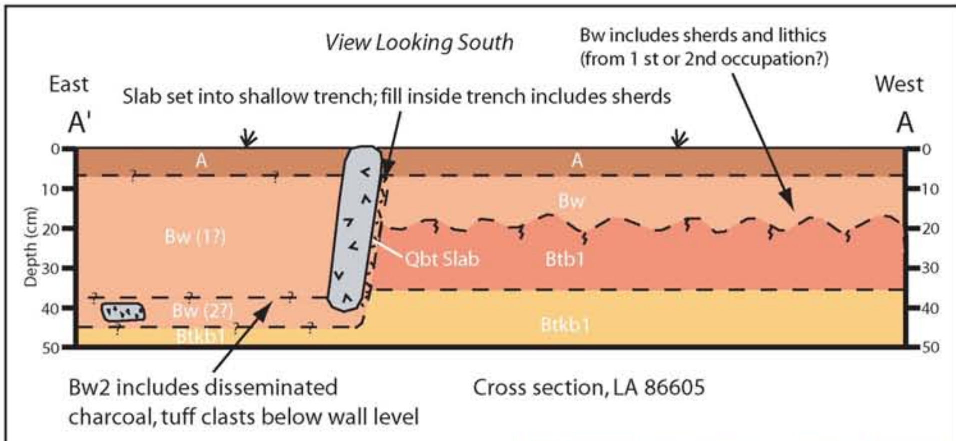
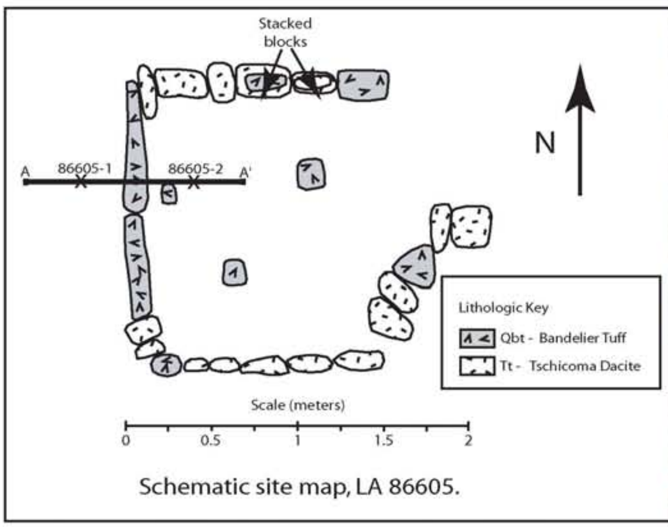
SURFICIAL UNITS AND PROCESSES ASSOCIATED WITH ARCHAEOLOGICAL SITES IN SELECTED LAND CONVEYANCE PARCELS, LOS ALAMOS NATIONAL LABORATORY, VOLUME III

2004 Field Season Investigations: Western Rendija Canyon Tract Sites



Cross section, LA 86605



Schematic site map, LA 86605.

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INTRODUCTION

Geomorphic studies were conducted in selected land conveyance parcels at Los Alamos National Laboratory in support of archaeological investigations preceding transfer of these tracts from the Department of Energy to Los Alamos County, San Ildefonso Pueblo, or the New Mexico Highway Department. This work included mapping and description of surficial geologic units to help define the geomorphic context of archaeological sites. This investigation also focused on identification of surficial processes associated with potential erosion or burial of cultural features. Fieldwork was conducted during the 2004 field season in support of excavations at twelve sites in the Rendija Canyon tract. Eleven of the sites were field houses, and one site was a storage bin.

GEOMORPHIC SETTING

Los Alamos National Laboratory is located on the Pajarito Plateau and includes a variety of landforms including gently sloping mesa tops, steep canyon walls, and canyon bottoms. This area has a complex geomorphic history over the last 10 to 15 thousand years, the time scale relevant to archaeological investigations (e.g., Reneau and McDonald, 1996; Reneau et al., 1996). At various times, large parts of the landscape experienced deposition of alluvial, colluvial, or eolian sediments, with an associated potential to bury and help preserve archaeological sites. The landscape has also experienced significant erosion, with the associated potential to erode archaeological sites.

METHODS

Surficial geologic maps of selected land transfer tracts were prepared at a scale of 1:1200. The Rendija Canyon tract geologic map was completed during the 2003 field season, and included an area mapped previously (Reneau and McDonald, 1996, p. 102). The mapping focused on units with potential archaeological significance. Soil descriptions were made at profiles both inside and outside of identified archaeological sites following methods discussed in Birkeland (1999). Carbonate stage for soils follows nomenclature developed by Gile et al. (1965, 1966). Preliminary age estimates for deposits were made based on soil descriptions and comparison of the general degree of soil development to previously dated sites on the Pajarito Plateau, and to soils described during the present investigation where ^{14}C dates were obtained.

Preliminary age estimates for soils in Rendija Canyon are based on comparison with a chronosequence of Pleistocene and Holocene soils developed on a terrace sequence in Rendija

Canyon (Reneau and McDonald, 1996; McDonald et al., 1996; Phillips et al., 1998). Age constraints for the Rendija Canyon fluvial terraces are provided by 13 radiocarbon dates for Holocene terraces, two radiocarbon dates for Pleistocene terraces, and cosmogenic ^{21}Ne age estimates for three terraces. Additional data for Rendija Canyon soil age estimates are based on comparison with soils described in paleoseismic trenches in Chupaderos Canyon, northwest of the Rendija tract (Gardner et al., 2003).

RENDIJA CANYON TRACT

Surficial Geologic Units

The Rendija Canyon land transfer tract is located within the Rendija Canyon watershed and includes part of the active stream channel and adjacent floodplains, tributary drainages, fluvial terraces, colluvial slopes, ridge crests and mesitas (Figure 1). The western half of the Rendija Canyon land transfer tract was the focus of the 2004 field season investigation. Geologic units beneath the Rendija Canyon tract include, from oldest to youngest, Tschicoma Formation dacite lavas (unit Tt); Puye Formation (unit Tp), an alluvial fan complex derived from the Tschicoma highlands that includes abundant Tschicoma dacite pebbles, cobbles, and boulders; the Otowi Member of the Bandelier Tuff (unit Qbo); Cerro Toledo interval (unit Qct) pumice beds and dacite rich alluvium with minor obsidian pebbles; the Tshirege Member of the Bandelier Tuff (unit Qbt), and Older Alluvium (unit Qoa) (Figure 2). Unit Qoa is stratified alluvium deposited on top of the Bandelier Tuff generally prior to incision of the modern canyons (Kempter and Kelley, 2002), possibly within 100,000 years of eruption of Qbt (Reneau and McDonald, 1996; Reneau et al., 2002). As mapped, unit Qct may include the Guaje Pumice Bed of the Otowi Member, Bandelier Tuff (Qbog), which produces pumice-rich soils similar to soils found overlying Qct.

Bedrock on hillslopes and ridge tops comprising the western half of the tract includes Tschicoma Formation dacite overlain by pumice and alluvium of the Cerro Toledo interval. The Tschicoma dacite crops out along a ridge north of the confluence between Rendija and Cabra Canyons, forms ridges along the northern tract boundary, and forms the highlands leading up to Guaje Mountain north of the tract (Figure 1; Kempter and Kelley, 2002). Puye Formation gravels and the Otowi Member of the Bandelier Tuff crop out in Rendija Canyon and along tributary drainages incised below the Cerro Toledo interval deposits (Figure 1). Cerro Toledo deposits crop out along the south side of Cabra Canyon, the north side of Cabra Canyon west of the Tschicoma dacite ridge, and along the north side of Rendija Canyon east of the Tschicoma dacite ridge (Figure 1). The Tshirege Member of the Bandelier Tuff forms the mesa top between Cabra and Rendija Canyons west of the Rendija Canyon tract, and crops out along the base of the mesa escarpment along the southern boundary of the tract (Figure 1). Fluvial terraces are preserved near the canyon bottom and are inset into or interfinger with colluvial deposits on north-facing slopes south of the Rendija Canyon drainage (Figure 1). Rendija Canyon possesses the most extensive and best-preserved set of stream terraces on the Pajarito Plateau, locally including at least five Pleistocene surfaces and four Holocene surfaces (Reneau and McDonald, 1996; McDonald et al., 1996). Parts of the tract are covered by locally derived colluvial or slopewash deposits of a variety of ages. Geologic maps of this area have been prepared by Griggs (1964), Smith et al. (1970), and Kempter and Kelley (2002). The Rendija Canyon terrace sequence was first examined by Gonzalez and Gardner (1990) and later by Wong et al. (1995). A detailed surficial geologic map of the western part of the tract was previously prepared by Reneau (Reneau and McDonald, 1996, p. 102), and is modified for this investigation in Figure 1.

Unit Qal consists of young alluvium in the main stream channel of Rendija Canyon. Sediment sources for Rendija Canyon alluvium include Bandelier Tuff and Cerro Toledo beds that provide sand and pumice, and Puye Formation beds and Tschicoma Formation dacite outcrops that provide the majority of the pebble to boulder-size gravel (McDonald et al., 1996).

Unit Qt includes several stream terraces flanking the Rendija Canyon stream channel. Stream terraces are labeled Qt1 through Qt8, from oldest to youngest. The Holocene terraces (Qt5 through Qt8) are typically strath terraces, with 0.5 to 2 m of channel deposits overlain by fine-grained floodplain sediments (Reneau and McDonald, 1996). Pleistocene terraces (Qt1 through Qt4) are typically overlain by more significant aggradational sequences consisting of 4 to 10 m of gravelly deposits (Reneau and McDonald, 1996). Terraces are in part overlain by colluvium (unit Qc). The older, higher terraces are more extensively buried by colluvium, and many of the Qt1 terraces are completely buried (Figure 1). A high terrace, Qt2, forms a large, relatively flat surface sloping to the east on which several field house sites are located (Figure 1). The coarse stream-gravel deposit underlying both Qt1 and Qt2 contains abundant dacite cobbles and boulders that would have been a ready source of wall block materials for the field houses.

Unit Qc includes a mixture of gravelly and fine-grained (fine to very fine sand and silt) slopewash colluvium deposited by overland flow, and also includes rocky colluvium on hillslopes below mesas and ridge crests. Qc includes valley-filling colluvial deposits that were locally reworked by fluvial processes, and eolian deposits and/or locally reworked eolian sediment. Qc includes deposits with a wide age range, and typically has buried soils that indicate pauses in deposition, in part accompanied by local erosion. However, at least two relatively widespread episodes of colluvial deposition are inferred from an examination of soil profiles at the Rendija Canyon sites. These depositional events include colluvium of inferred late Pleistocene to middle Holocene age, typically less than 1.5 m thick, overlain by a late Holocene colluvial deposit less than 25 cm thick (Drakos and Reneau, 2004). Local swale-fill and gully-fill deposits preserve relatively thick (greater than 1 m) early to mid Holocene colluvial deposits buried by late Holocene deposits that could potentially contain buried Archaic or Paleoindian sites (Drakos and Reneau, 2004).

Age estimates for young colluvial and eolian deposits that bury Field house sites in the western Rendija tract are based on calibrated ^{14}C ages obtained from charcoal samples collected from soils described in Rendija Canyon during earlier phases of this investigation, from stratigraphic relationships with dated cultural materials, and based on comparison with soils described at Coalition and Classic period sites in the Airport and White Rock tracts (Drakos and Reneau, 2003; 2004).

LA 15116 (Field house)

LA 15116 consists of a field house situated on a north-facing slope below the Qt2 terrace surface (Figure 1). The structure measures approximately 2.5 m north-south by 1.9 m east-west (inside), or 3 m north-south by 2.5 m east-west (outside dimensions). Soils were described in one test pit at the site, located 1 m west of the west side of the field house. Site stratigraphy consists of an A-Bw soil overlying a buried mid to early Holocene stripped soil (Btb1 horizon; Figure 3, Table 1). Depth to Otowi tuff (?) bedrock, observed west of the structure, is approximately 0.4 m (Figure 3).

The field house was constructed primarily from dacite blocks, with some tuff blocks also utilized. The occupation surface at the site is the top of the Btb1 horizon, and post-occupation colluvial deposits are 20 cm thick at the described profile. Dacite blocks, inferred to be wall fall, were observed in the A and Bw horizons (Figure 3). Although intensively burned during the Cerro Grande fire, the site does not show evidence of extensive erosion. Soils burying LA 15116 are relatively weakly developed, but have developed A-Bw horizons. The soils and related stratigraphy are therefore consistent with LA 15116 being a Classic, or possibly a Coalition period feature, and the site is in relatively good archaeological context.

LA 70025 (Field house)

LA 70025 consists of a field house in Cabra Canyon situated on a narrow ridge that forms part of a deeply dissected colluvial slope overlying fluvial terrace gravel or Cerro Toledo gravel. The structure measures approximately 1.8 m by 1.6 m (inside), or 2.2 m by 2 m (outside dimension), situated with the long axis of the structure oriented N20°W (Figure 4). Soils were described in one test pit at the site, located 2 m west of the west side of the field house (Figure 4; Table 1). Site stratigraphy consists of an A-Bw1-Bw2 soil overlying a buried mid to late Holocene Btjb1 horizon (Figure 4; Table 1).

The field house was constructed primarily from tuff blocks, with some dacite blocks also utilized. The occupation surface at the site is the top of the Btjb1 horizon (Figure 4). The site is situated in an erosional setting, with the potential for transport of artifacts from the ridgetop to the hillslope below. Soils burying the LA 70025 occupation surface outside the structure are relatively thick in a local low area on the ridge, 29 cm thick at the described soil profile, and include the development of Bw1 and Bw2 horizons. Soils inside the structure on a local topographic high are relatively thin, and likely indicate erosion of the site. The soils data and related stratigraphy are suggestive of a Coalition or early Classic period age for LA 70025. The site is in relatively poor archaeological context.

LA 85403 (Field house)

LA 85403 consists of a field house situated on a relatively flat Qt2 terrace surface (Figure 1). The structure measures approximately 2.1 m by 1.8 m (inside), or 2.5 m north-south by 2.1 m east-west (outside dimensions), and contains an opening facing east (Figures 5 and 6). Soils were described in two test pits at the site. A complete soil profile was described 1.4 m west of the west wall of the field house, and a partial profile was described below the west wall (Figures 5 and 6; Table 1). Site stratigraphy consists of an A-Bw soil overlying a buried early to mid Holocene Bwb1-Btb1 soil (Figure 6; Table 1).

The field house was constructed primarily from dacite slabs and blocks, with a minor component of tuff blocks also utilized. The wall blocks were partially buried by a fine-grained eolian deposit, and were observed to protrude up to 5 to 10 cm above present ground surface. Exposed wall blocks were lichen-covered. Based on the absence of evidence of significant surface erosion and the observed burial of the site by eolian material, the site appears to be in good archaeological context.

Dacite slabs were set into the Bwb1 horizon and possibly into the Bw horizon (Figures 5 and 6). Evidence for the actual occupation surface outside the structure was not conclusive, and this surface may have been either the top of the Bwb1 horizon or the top of the Bw horizon. The prevalence of wall fall in the A horizon, observed in the excavation wall west of the field house (Figures 5 and 6), though not conclusive, provides some supporting evidence that the top of the Bw horizon was the occupation surface. Post-occupation eolian deposition was thus either 9 cm or 22 cm, with the A horizon and possibly the Bw horizons developing after site abandonment. Based on soil stratigraphy at other sites (Drakos and Reneau, 2004), the interpretation that the occupation surface was the top of the Bw horizon would be most consistent with a Classic period age for the site, and the interpretation that the occupation surface was the top of the Bwb1 horizon would be most consistent with a Coalition period age for the site.

LA 85404 (Field house)

LA 85404 consists of a field house situated on the gently sloping, east-facing edge of a Qt1 terrace surface (Figure 1). The field house outside dimensions are approximately 3 m north-south by 2.5 m east-west on the north side of the structure, and 1.8 m east-west on the south side of the structure (Figure 7). Inside dimensions are approximately 1.2 to 1.7 m east-west by 2.2 m north-south. Soils were described in two test pits at the site; profile 85404-1 was described inside the structure and profile 85404-2 was described 1.5 m west of the west wall of the field house (Figures 7 and 8; Table 1). Site stratigraphy consists of an A-Bw soil overlying a buried Pleistocene Btb1 soil outside the structure, and an A-Bw1-Bw2 profile overlying the Pleistocene soil inside the structure (Figure 7).

The field house was constructed from locally derived dacite blocks that appear to have been set into a trench dug into the Btb1 horizon (Figure 7). The top of the Btb1 horizon outside the structure and the top of the Bw2 horizon inside the structure constitutes the likely occupation surface. The Bw2 horizon inside the structure contained worked chert with clay films plus possible reworked peds that suggests earlier use of this site and preparation of a subfloor. The site did not exhibit extensive erosion and appears to be in good archaeological context. The thin colluvial soil observed outside the structure, about 9 cm thick, indicates a relatively young age for this site, although the thicker soil inside the structure is suggestive of a relatively older age. The soils and related stratigraphy are therefore consistent with LA 85404 being a Classic period site, but do not preclude a Coalition period age.

LA 86605 (Field house)

LA 86605 consists of a field house situated on the broad, gently sloping, east-facing shoulder of the Qt2 terrace (Figure 1). The structure measures approximately1.7 m north-south by 1.5 m east-west (inside dimensions), or 2.1 m north-south by 2 m east-west (outside dimensions), and contains an opening facing east (Figure 9). Soils were described in two test pits at the site; profile 86605-1 was described 1.1 m west of the west wall of the field house and profile 86605-2 was described inside the structure, approximately 0.4 m east of the west wall (Figure 9; Table 1). Site stratigraphy consists of an A-Bw soil overlying a buried Pleistocene or early Holocene Btb1-Btkb1 soil outside the structure, and an A-Bw1(?)-Bw2(?) profile overlying the buried soil inside the structure (Figure 10). The Bw2 horizon inside the structure contains disseminated charcoal and tuff clasts below the level of the bottom of the roomblock walls, providing evidence for an earlier period of occupation at this site.

The field house was constructed utilizing dacite and tuff blocks and slabs, with two large Bandelier Tuff slabs used to construct most of the west wall (Figure 9). The dacite was likely obtained from the local Qt2 terrace gravels, and the tuff may have been obtained from outcrops in a nearby drainage to the east. The slabs are set into a trench dug into the Bw, Btb1 and Btkb1 horizons (Figure 10). Sherds were observed in the clayey fill in the trench, providing additional evidence that the structure was built on top of an older site. The top of the Btb1 horizon (outside the structure) and the top of the Btkb1 horizon (inside the structure) is the likely occupation surface for the first occupation of this site. The second period of construction appears to have recycled clasts from the earlier construction phase, and built on top of old fill. The top of the Bw2 horizon inside the structure constitutes the likely occupation surface for the latest occupation at this site. Outside the structure the relations are less clear. The occupation surface for the inferred first occupation at this site was likely at the top of the Btb1 horizon, and for the latest occupation could have been at this level but, based on the shallow trench fill next to the slab that appears to extend through the Bw horizon, was likely the top of the Bw horizon. Total deposition outside the structure since initial occupation was about 19 cm, and since the latest occupation may have been as little as 7 cm.

LA 86605 is buried by slopewash colluvium and reworked eolian fine sand, but did not exhibit extensive erosion and appears to be in good archaeological context. The Bw horizon that buries this site is reddened and has a hard consistence, suggesting a relatively older site age for the first occupation, whereas the thin A horizon burying the likely occupation surface at the top of the Bw horizon suggests a relatively young age for the second occupation. The soils and related stratigraphy are therefore consistent with LA 85404 having an earlier, Coalition period occupation and a later, likely Classic period occupation.

LA 87430 (Field house)

LA 87430 consists of a field house with an external hearth situated on the north edge of a Qt5 terrace overlooking the Rendija Canyon stream channel (Figure 11). The structure measures approximately 1.85 m north-south by 2.1 m east-west (inside dimensions), or 2.4 m north-south by 2.4 to 2.8 m east-west (outside dimensions), situated with the short axis of the structure oriented N20°E, and contains an opening facing east-southeast (Figure 10). Soils were described in one test pit at the site, located 2 m east of the east side of the field house (Figure 11; Table 1). Site stratigraphy consists of an A-Bw soil overlying a buried mid Holocene Btb1 horizon (Figure 11; Table 1).

The field house was constructed primarily from dacite blocks, with some tuff blocks also utilized. The occupation surface at the site is on, or just above the top of the Btb1 horizon (Figure 11). Rocks for wall construction were either set on top of, or in some cases were set into a shallow trench into the Btb1 horizon (Figure 11). The site has been subject to some erosion on the north side and deposition on the south side of the structure. LA 87430 is buried by a weakly developed soil in a colluvial deposit that is 18 cm thick where described. The soils data and related stratigraphy are suggestive of a Classic period age for LA 87430. Although built on the edge of the terrace above a steep stream bank, the walls appeared to be relatively well preserved and the site is likely in good archaeological context.

LA 127627 (Field house)

LA 127627 consists of a field house situated on a northwest-facing slope below the Qt2 terrace surface (Figure 1). The structure measures approximately1.9 m by 1.7 m (inside dimensions), or 2.3 m by 2.1 m (outside dimensions), situated with the long axis of the structure oriented approximately N40°W, and contains an opening in the northeast corner (Figure 12). Soils were described in one test pit at the site, located 0.5 m east of the east corner of the field house (Figures 12 and 13; Table 1). Site stratigraphy consists of an A-Bw soil overlying a buried Pleistocene Btb1 soil (Figure 12; Table 1).

The field house was constructed primarily from dacite blocks, presumably obtained from the Qt2 terrace deposit. Some *in situ* dacite boulders were utilized for field house construction, as evidence by the presence of clay films on the lower half of the boulders (Figure 12). The LA 127627 structure was constructed on a slope, and the floor appears to have been leveled by cutting into the slope above and filling on the downslope side of the field house. The occupation surface at the site is the top of the Bt1b1 horizon (Figures 12 and 13). LA 127627 is buried by a relatively weakly developed soil in a colluvial deposit, but the Bw horizon has a hard consistence. Post-occupation colluvial deposits are 21 cm thick at the described profile near the east wall. The soils data and related stratigraphy are suggestive of a Classic period or possibly Coalition period age for LA 127627. The site has been subject to some erosion and transport of wall blocks as part of the colluvium but still has relatively intact walls, and site preservation has been aided by colluvial deposition. The site is in poor to moderate archaeological context.

LA 127633 (Storage bin)

LA 127633 consists of a slab-lined storage bin on a sloping, south-southeast-facing colluvial hillslope that may be graded to the middle to late Holocene Qt7 terrace. The storage bin is located near the top of a 25° hillslope below a ridge spur. This small structure measures approximately 1.0 m by 0.7 m (inside dimensions), or 1.3 m by 1 m (outside dimensions), situated with the long axis of the structure oriented N77°E (Figure 14). Soils were described in two test pits at the site; profile 127633-1 was described several meters southwest of the structure and profile 127633-2 was described outside of the west wall of the structure (Figure 14; Table 1). Site stratigraphy consists of an A-BC or A-BC-C soil overlying a buried middle(?) Holocene Bw or Btjb1 soil (Figure 14; Table 1).

The storage bin was constructed utilizing dacite slabs and tuff blocks (Figure 14). The dacite slabs were likely obtained from a dacite outcrop located a short distance up-slope from the site. The slabs were set into a young aggrading colluvial deposit, with some additional burial of the slabs occurring after construction of the storage bin. The likely occupation surface at LA 127633 is within the upper part or at the top of the BC horizon. The dark staining on the slabs (see Figure 14) was caused by subsurface weathering and suggests a greater than historic age for this structure. The dark staining may indicate burial of the structure soon after abandonment, or may have occurred subsequent to the slabs having been emplaced in the subsurface. If the slabs were emplaced in the subsurface, the storage bin only experienced partial burial in the last 100 years. The weak soil development both above and below the structure indicates a likely Classic period age. The upper 5 to 10 cm of colluvium buries a small (17-cm diameter) ponderosa pine with an estimated age of less than 100 years, indicating 5 to 10 cm of post-AD 1900 colluvial deposition at the site. This approximately corresponds to the thickness of the A horizon and of the "no lichen" band on the slabs (Figure 14), indicating that the A horizon formed in very young colluvium and that the staining likely requires more than 100 years for formation.

The site is relatively steep and has been subject to some erosion and downslope transport of archaeological materials, including several dacite slabs as part of the colluvium. The site is therefore in moderate to poor archaeological context.

LA 127634 (Field house)

LA 127634 consists of a field house situated on a south-facing Qct or Qbog hillslope (Figure 1). The structure measures approximately 2.5 m east-west by 1.8 m north-south (inside dimensions), or 3 m east-west by 2 m north-south (outside dimensions), contains a south-facing entryway and a hearth in the southeast corner (Figure 15). Soils were described in one test pit at the site, located 2 m west of the northwest corner of the field house (Figure 15; Table 1). Site stratigraphy consists of an A horizon overlying a buried late Pleistocene or Holocene Btkb1 soil (Figure 15; Table 1). The Btkb1 horizon is developed in a thin colluvial deposit overlying a Qct or Qbog pumice deposit.

The field house was constructed from a mixture of dacite and tuff blocks. The occupation surface at the site is a prepared clay floor constructed on top of the Btkb1 horizon (Figure 15). LA 127634 is buried by a thin, weakly developed soil in a colluvial deposit, with only an A horizon. Post-occupation colluvial deposits are 6 cm thick at the described profile 2 m west of the west wall. The soils data and related stratigraphy are consistent with a Classic period age for LA 127634. The site is buried by a thin colluvial deposit and is not extensively eroded, and therefore appears to be in relatively good archaeological context.

LA 127635 (Field house)

LA 127635 consists of a field house situated on a colluvial wedge on the back (south) side of a pre-Qt6 terrace remnant on the north side of Rendija Canyon (Figure 1). The terrace remnant buried by colluvium forms a small spur between drainages. The structure measures approximately 3 m east-west by 2 m north-south (outside dimensions), situated with the long axis of the structure oriented approximately N75°E, and contains an opening facing east-northeast (Figure 16). A hearth is located adjacent to the north wall, on the inside of the structure. Soils were described in one test pit at the site, located 0.5 m east of the east side of the field house. Site stratigraphy consists of an A-Bw soil overlying a buried mid to late Holocene Bwb1-Bkb1 soil (Figure 16; Table 1).

The field house was constructed from Bandelier tuff blocks. The occupation surface at the site is the top of the Bwb1 horizon (Figure 16). LA 127635 is buried by a weakly developed colluvial soil with an A-Bw profile that includes wall fall in the deposit. Post-occupation colluvial deposits are 19 cm thick at the described profile near the east wall. The soils data and related stratigraphy are suggestive of a Classic period or Coalition period age for LA 127635. The walls are well preserved and colluvial deposition has aided site preservation, and the site is likely in good archaeological context.

LA 135291 (Field house)

LA 135291 consists of a field house situated on a north-facing slope below the top of the Qt2 terrace (Figure 1). The structure measures approximately 2.8 m east-west by 1.7 m north-south (inside dimensions), or 3.3 m east-west by 2.3 m north-south (outside dimensions). A possible feature is located in the northeast corner of the structure. Soils were described in one test pit at the site, located 1.6 m east of the east side of the field house. Site stratigraphy consists of an A-Bw soil overlying a buried Pleistocene Btb1 soil (Figure 17; Table 1).

The field house was constructed predominantly from Tschicoma dacite blocks, with a few Bandelier tuff blocks set on top of the Btb1 horizon. The occupation surface at the site is the top of the Btb1 horizon (Figure 17). LA 135291 is buried by slopewash colluvium and/or an eolian deposit, measuring 11 cm thick where described. This deposit has a weakly developed soil with an A-Bw profile with artifacts including biscuitware ceramics. The soils data and related stratigraphy are consistent a Classic period age for

LA 135291. With the exception of a few blocks scattered across the surface, the walls are well preserved, and the site is in moderate to good archaeological context.

LA 135292 (Field house)

LA 135292 consists of a field house situated on the gently northeast-sloping Qt2 terrace surface (Figure 1). The two remaining wall segments of the partially intact structure measure approximately 1.8 m north-south by 1.8 m east-west (Figure 18). The structure appears to have been partially disturbed by machinery. Soils were described in two test pits at the site; profile 135292-1 was described 1.3 m west of the west wall of the field house and profile 135292-2 was described inside the structure (Figure 18; Table 1). Site stratigraphy consists of a relatively thick A-Bw1-Bw2 soil overlying a buried Pleistocene Btb1-Bkb1 soil (Figure 18). The upper soil is formed in eolian and reworked eolian silty loam mixed with slopewash colluvium, and is 44 cm thick where described.

The field house was constructed from dacite blocks that appear to have been set on top of the Bw1 horizon (Figure 18). The top of the Bw1 horizon, which is similar to the post-Coalition deposits observed at the Airport and White Rock tract sites (Drakos and Reneau, 2003 and 2004), is the likely occupation surface. The site is buried by the A horizon deposit that is mounded inside the structure, and is 14 cm thick where described (Figure 18; Table 1). The soils and related stratigraphy are consistent with a Classic period age for LA 135292. Due to apparent disturbance of the north and east walls of the site, LA 135292 is in moderate to poor archaeological context.

TRACT SUMMARY

Sites investigated within the western Rendija Canyon tract during the 2004 field season include eleven field house sites and one storage bin. Eight of the sites were located on top of or on the side of well-developed Rendija Canyon stream terraces, including Qt1, Qt2, and Qt5 (Table 2). Sites were located both on relatively flat terrace surfaces (the tread) and on hillslopes below terrace surfaces (on terrace risers). Two sites were located on colluvial hillslopes overlying Qct or Qbog bedrock (Table 2). Two sites, including the Cabra Canyon site, were located on colluvial slopes overlying small terrace remnants (Table 2; Figure 1). All sites have experienced some deposition of eolian sediment and/or colluvium since abandonment, which has aided site preservation. The evidence for net deposition at these sites is consistent with evidence from most other Coalition and Classic period sites examined within the land transfer tracts (Drakos and Reneau, 2003, 2004). Although there is also evidence for erosion at some sites, particularly on the steeper slopes, the apparent predominance of deposition has created conditions of relatively good site preservation.

The field houses were constructed utilizing Tschicoma dacite blocks likely obtained from the terrace deposits, and Bandelier Tuff blocks and slabs likely obtained from nearby colluvial deposits or outcrops, possibly in part from surrounding mesas. In individual field houses, some were constructed predominantly or solely utilizing one lithology of building materials, whereas other field houses utilized a mixture of lithologies (Table 3). The storage bin (LA 127633) was constructed from dacite slabs probably obtained from a nearby Tschicoma dacite outcrop, and

Bandelier Tuff blocks. Clear relationships between type of building material, relative site age, and/or geomorphic position were not observed.

Based on soil stratigraphy of deposits burying the twelve sites investigated during the 2004 field season and comparison with soils described at Coalition and Classic period sites in the Airport and White Rock tracts (Drakos and Reneau, 2003; 2004), the field houses in the western Rendija Canyon tract may have been constructed from Coalition through Classic period time. Soil characteristics and depth of burial of the sites are used to provide relative age estimates of the 2004 field season sites (Table 2). Sites overlain by thin soils with only an A horizon or A-BC horizon development, including LA 127633, LA 127634, LA 135292, and LA 86605 (second occupation) appear to be the youngest sites investigated (relative age = 1 in Table 2) and based on soil characteristics are Classic period sites. Sites overlain by slightly thicker soils, typically with A-Bw horizon development, including LA 15116, LA 87430, LA 127627, LA 127635, and LA 135291 appear to be intermediate in age (relative age = 2 in Table 2) of the sites investigated. The intermediate-age sites are likely Classic period sites, although soils data do not preclude a Coalition period age. Sites overlain by thicker soils with A-Bw1-Bw2 profiles, or A-Bw profiles with reddened or hardened Bw horizons, including LA 70025, LA 85404, LA 86605 (first occupation) are inferred to be the oldest sites investigated (relative age = 3 in Table 2). Soil characteristics suggest that the “oldest”-age sites are Coalition period sites, although soils data do not preclude a Classic period age. One site, LA 85403, may be grouped with the youngest, Classic period sites if the top of the Bw horizon is the occupation surface, or is one of the older, Coalition period sites if the top of the Bwb1 horizon is the occupation surface. The soil and geomorphic evidence suggests that LA 85403 is one of the younger, Classic period sites.

The orientation of field house structures can be related to geomorphic position. Where building sites are relatively flat, expansive surfaces, structures are oriented with walls aligned along north-south and east-west axes, and if openings are present have east-facing doorways (Table 3). These sites include LA 85403, LA 86605, LA 135291, LA135292, and possibly LA 85404. Where building sites are located on hillslopes, the structure is typically oriented perpendicular to the hillslope (Table 3). Doorways, if present, generally face down-slope. Structures built on hillslopes with walls shifted off of a north-south/east-west axis include LA 127627 and LA 127633; structures built on north- or south-facing hillslopes with walls aligned on a north-south/east-west axis include LA 15116 and LA 127634. In other cases, structures are built to fit on small terrace remnants or ridge spurs, and are rotated off of a north-south/east-west axis. These field houses include LA 70025, LA 87430, and LA 127635 (Table 3).

CONCLUSIONS

Archaeological sites investigated within the western Rendija Canyon tract during the 2004 field season were located on Rendija Canyon terraces, including Qt1, Qt2, and Qt5, on hillslopes below terrace surfaces, and on colluvial hillslopes overlying either Qct bedrock or fluvial terrace deposits. With the exception of sites located on steep hillslopes or narrow ridge tops, and one site (LA 135292) that has been subject to surface disturbance, sites investigated during the 2004 field season were in relatively good archaeological context due in part to net deposition of eolian sediment or colluvium since abandonment. The field houses were constructed utilizing Tschicoma dacite blocks likely obtained from the terrace deposits, and Bandelier tuff blocks and slabs likely obtained from nearby colluvial deposits or outcrops, and possibly in part from surrounding mesas. Tschicoma dacite slabs were less commonly used.

Soil stratigraphic data suggest the field houses in the western Rendija Canyon tract were constructed from Coalition through Classic period time. Sites overlain by thin soils with only an A horizon or A-BC horizon development appear to be the youngest sites investigated and based on soil characteristics are Classic period sites. Sites overlain by slightly thicker soils, typically with A-Bw horizon development, appear to be intermediate in age and are likely Classic period sites, although soils data do not preclude a Coalition period age. Sites overlain by thicker soils with A-Bw1-Bw2 profiles, or A-Bw profiles with reddened or hardened Bw horizons appear to be the oldest sites investigated and may be Coalition period sites, although soils data do not preclude a Classic period age.

The orientation of field house structures can be related to geomorphic position. Where building sites are relatively flat, expansive surfaces, structures are oriented with walls aligned along north-south and east-west axes, and if openings are present have east-facing doorways. Where building sites are located on hillslopes, the structure is typically oriented perpendicular to the hillslope. Doorways, if present, generally face down-slope. In other cases, structures are built to fit on small terrace remnants or ridge spurs, and may be oriented off of a north-south/east-west axis to fit on a particular geomorphic surface.

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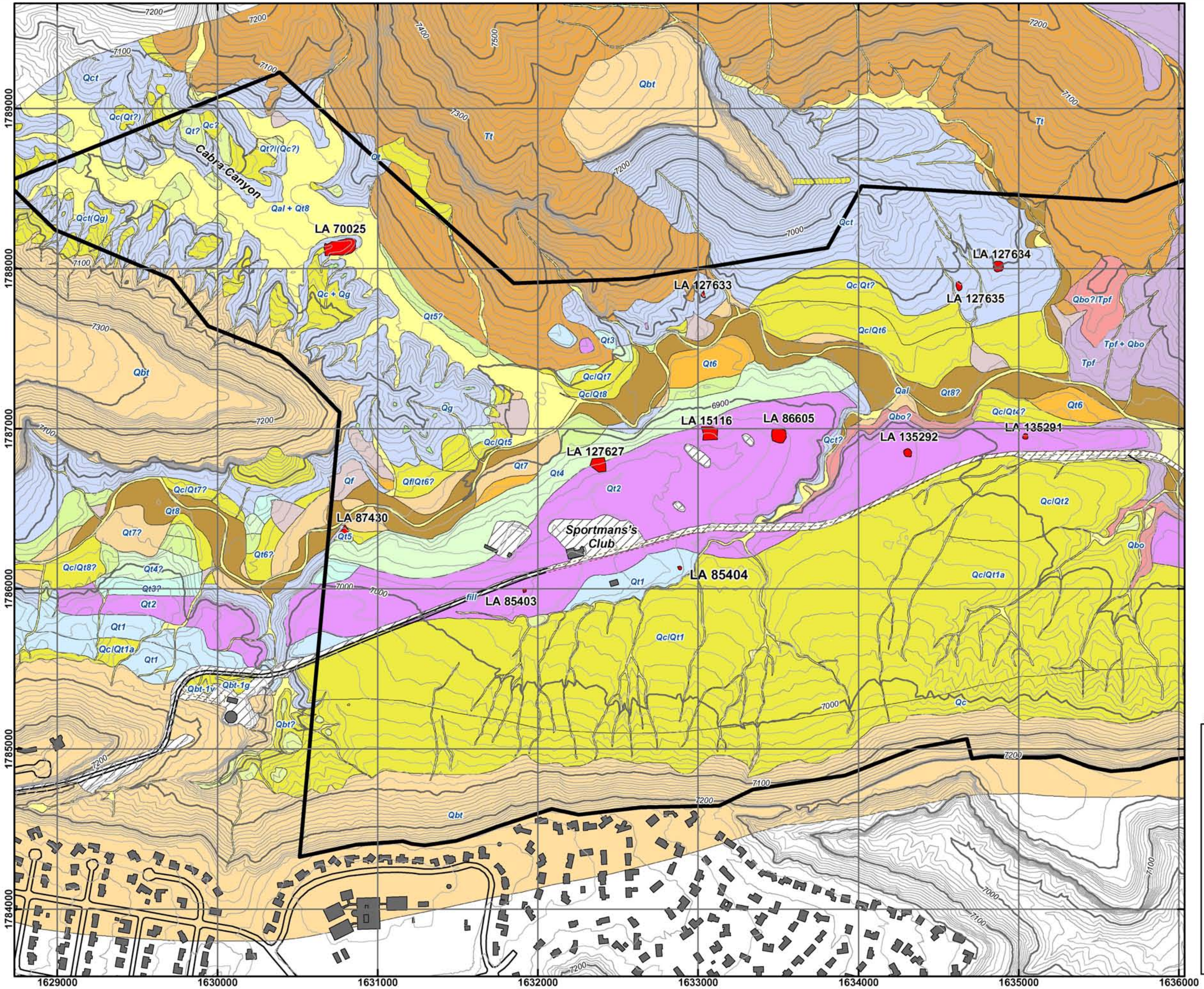
FIGURES

Figure 1. Western Rendija Tract Geomorphology



Legend

Structure		Qt1	
Cultural site excavated in 2004 field season		Qt2	
Rendija Tract		Qt3	
Geomorphology		Qt4	
Fill		Qt5	
Qal		Qt6	
Qc		Qt7	
Qf		Qt8	
Qbo		Tpf	
Qct		Tt	
Qg		Qbt	

Contour interval = 10 feet

Source Statements:

Grid: New Mexico Central State Plane Coordinates

State Plane Coordinate System, New Mexico, Central Zone, US Foot
GeoMorphology, LANL, ;
ENV Remediation Services Project, ECR GIS,
Unpublished data generated for map
05-0013; 1 March 2005.
Paved and dirt roads arcs; Los Alamos National Laboratory,
KSL Site Support Services, Planning, Locating and Mapping Section;
06 January 2004; Development Edition of 06 January 2005
Structures; LANL,
KSL Site Support Services,
Planning, Locating and Mapping Section;
06 January 2004; Development Edition
of 05 January 2005.
Hypsography:
10 and 100 Foot Contour Interval;
Los Alamos National Laboratory,
RRES Remediation Services Project; 1991

Los Alamos
NATIONAL LABORATORY

By Paul G. Drakos & Steven L. Reneau

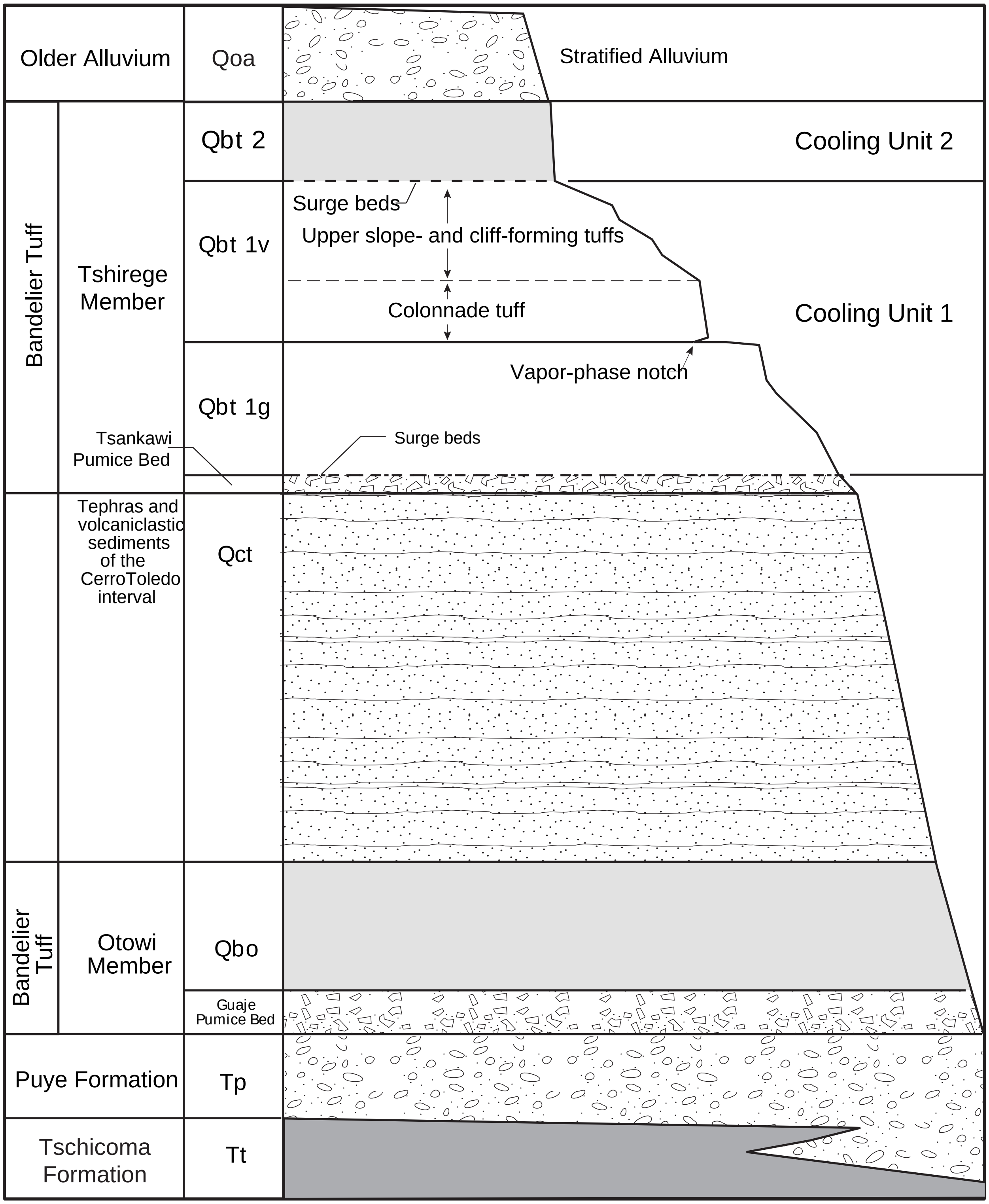
0 110 220 440 Meters

0 250 500 1,000 1,500 Feet

Map created March 4, 2005 by Winters Red Star (ENV-ECR GIS) Geomorphic mapping by P. Drakos and S. Reneau, August 2003. Cultural data maintained by Cultural Resources Management Team, ENV-ECO.

Projection: StatePlane Coordinate System: New Mexico, Central Zone, US Feet

Map # 05-0013-01



Modified from Broxton and Reneau, 1995

Figure 2. Generalized stratigraphic column for the Rendija Canyon area

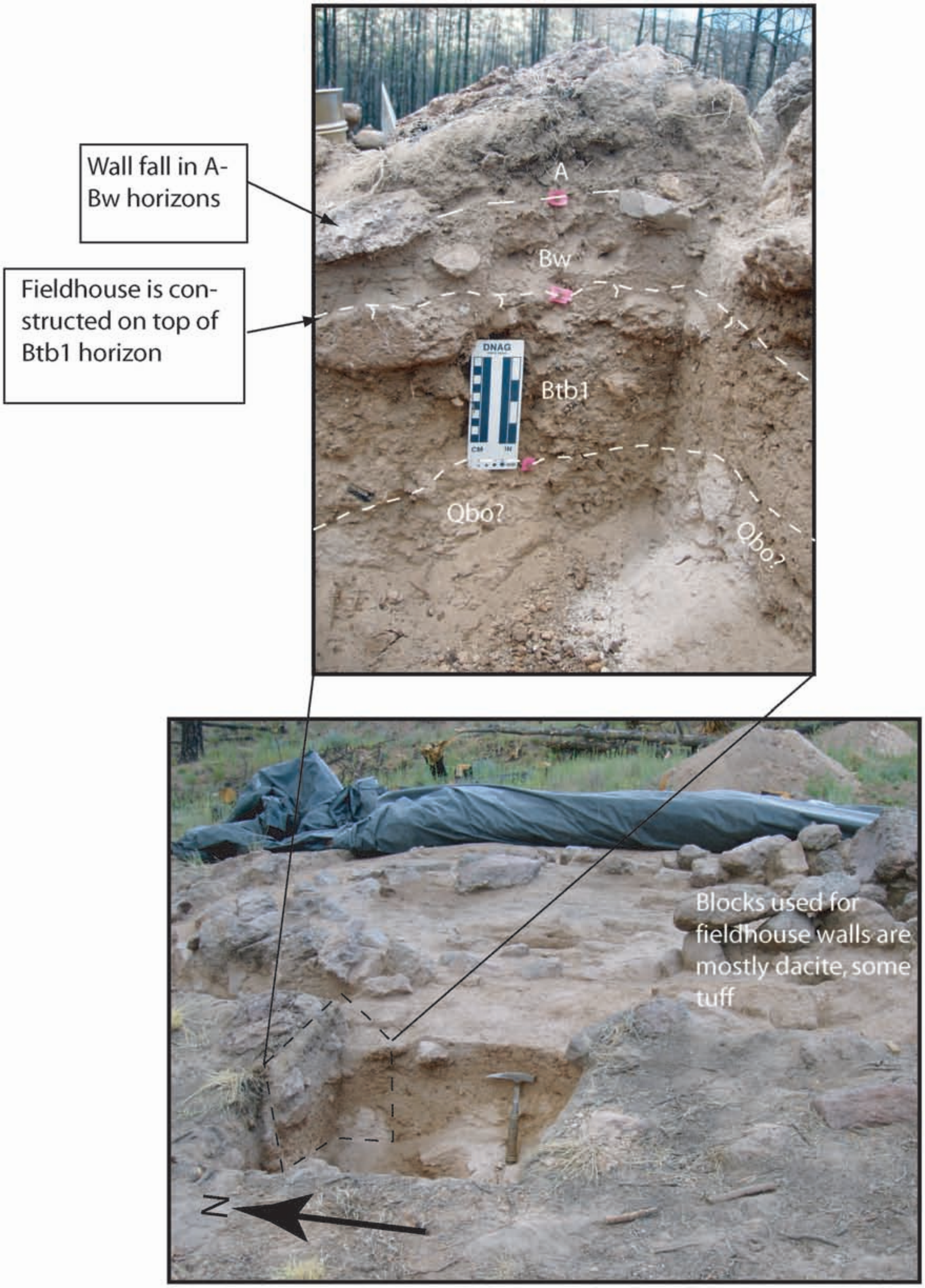


Figure 3. Photographs showing soil stratigraphy (top) and soil pit next to fieldhouse (bottom), LA 15116.

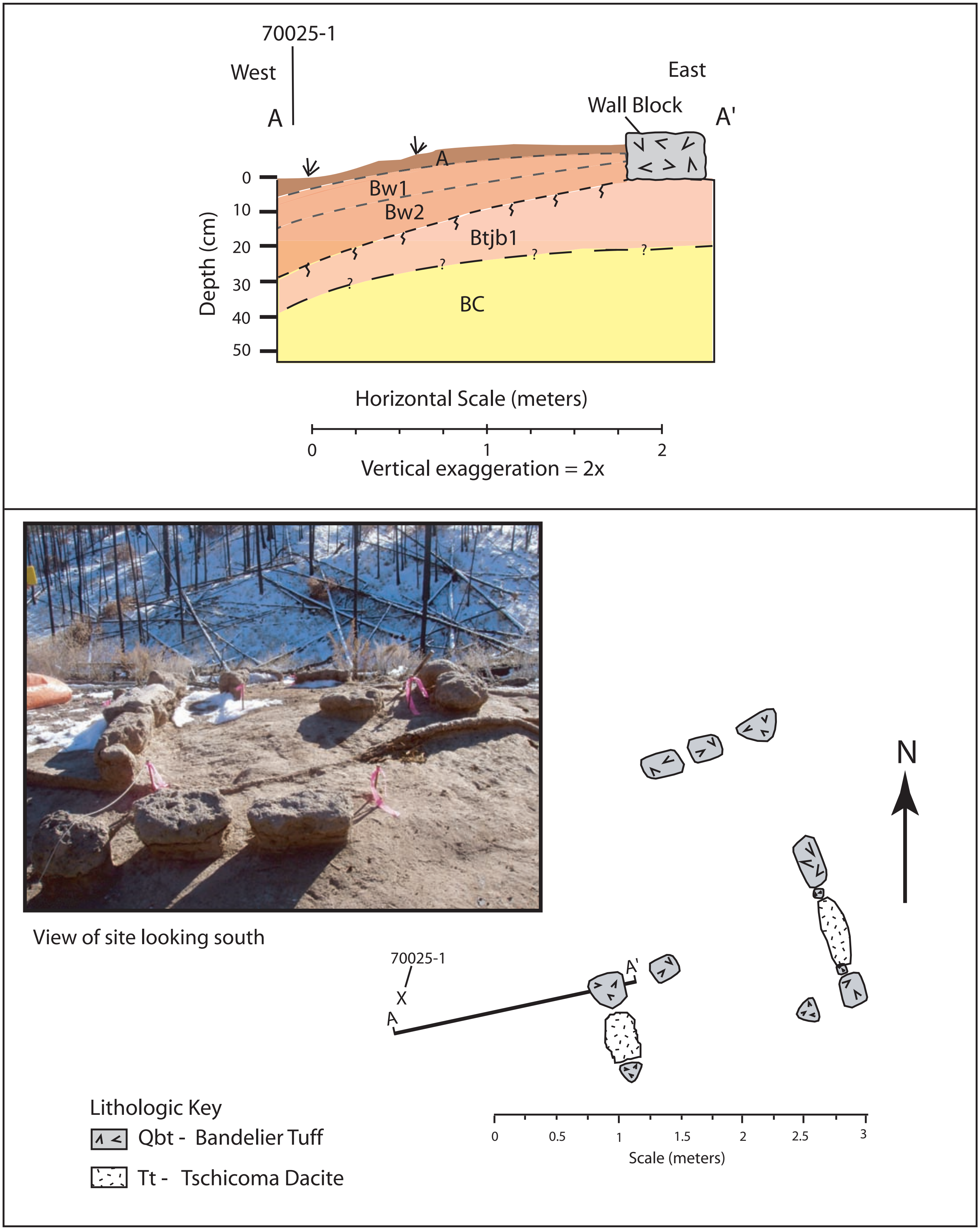


Figure 4. Schematic site map (plan view, bottom right), cross section (top), and site view looking south (bottom left), LA 70025.

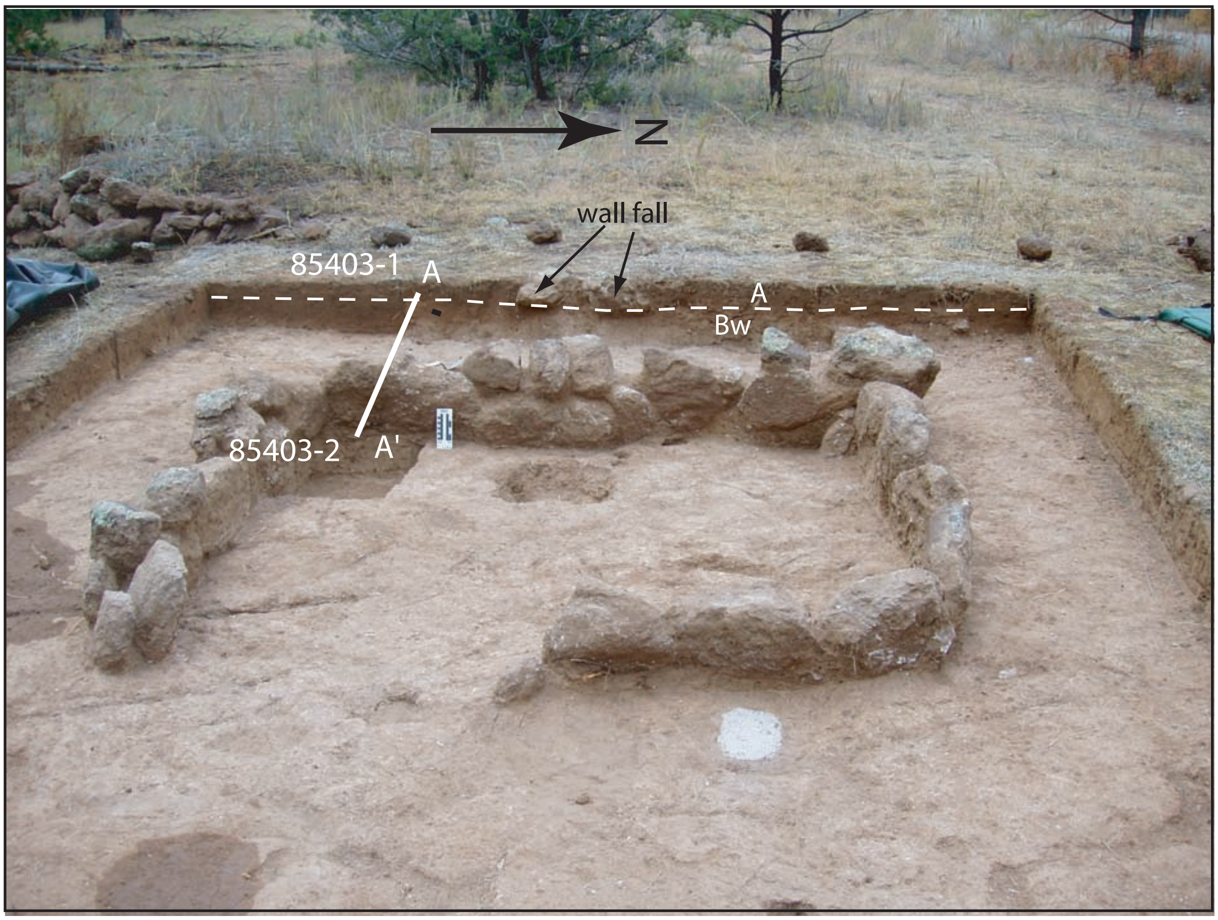


Figure 5. Photograph of LA 85403 looking west showing cross section and soil description locations.

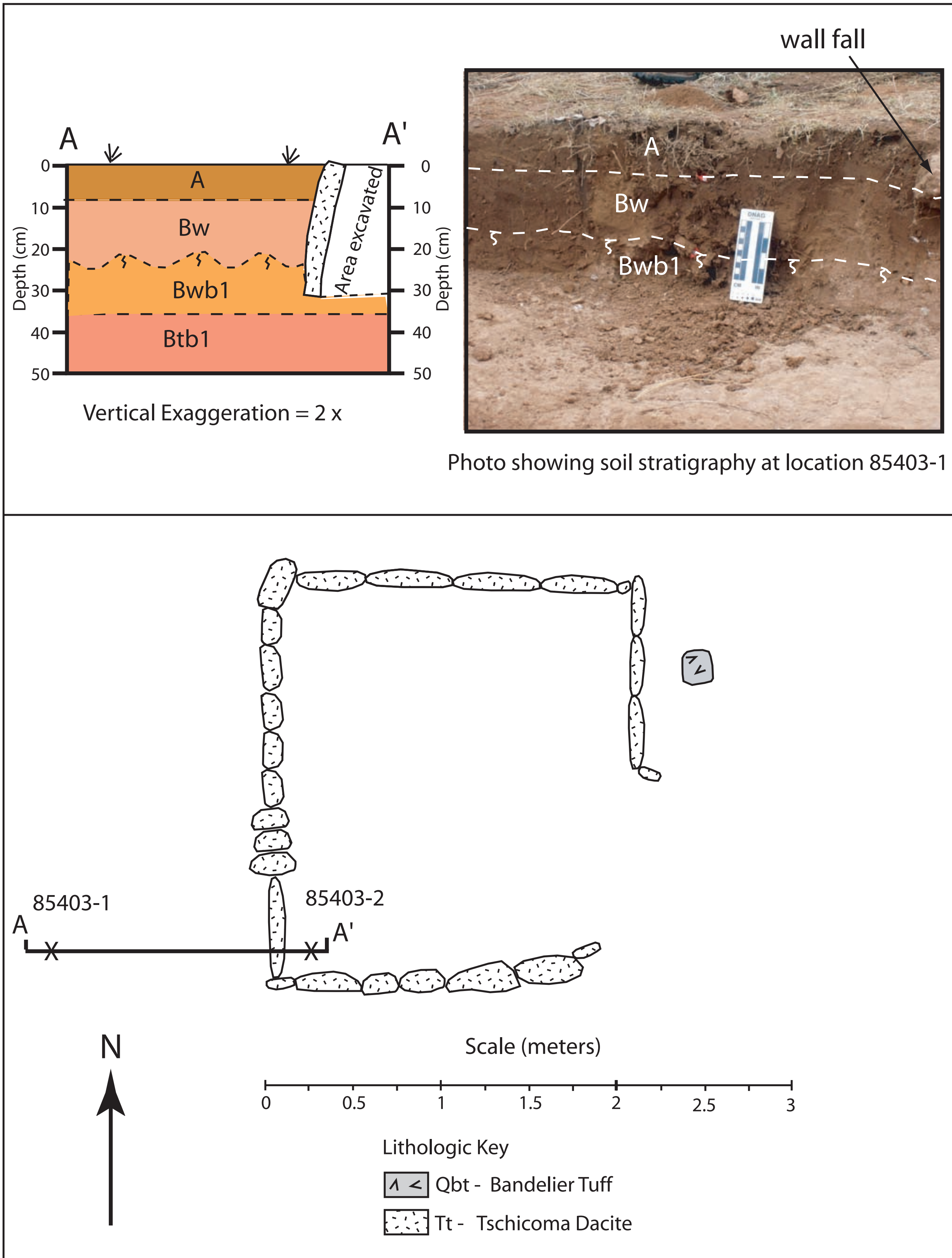


Figure 6. Schematic site map (plan view, bottom) and cross section (top), LA 85403.

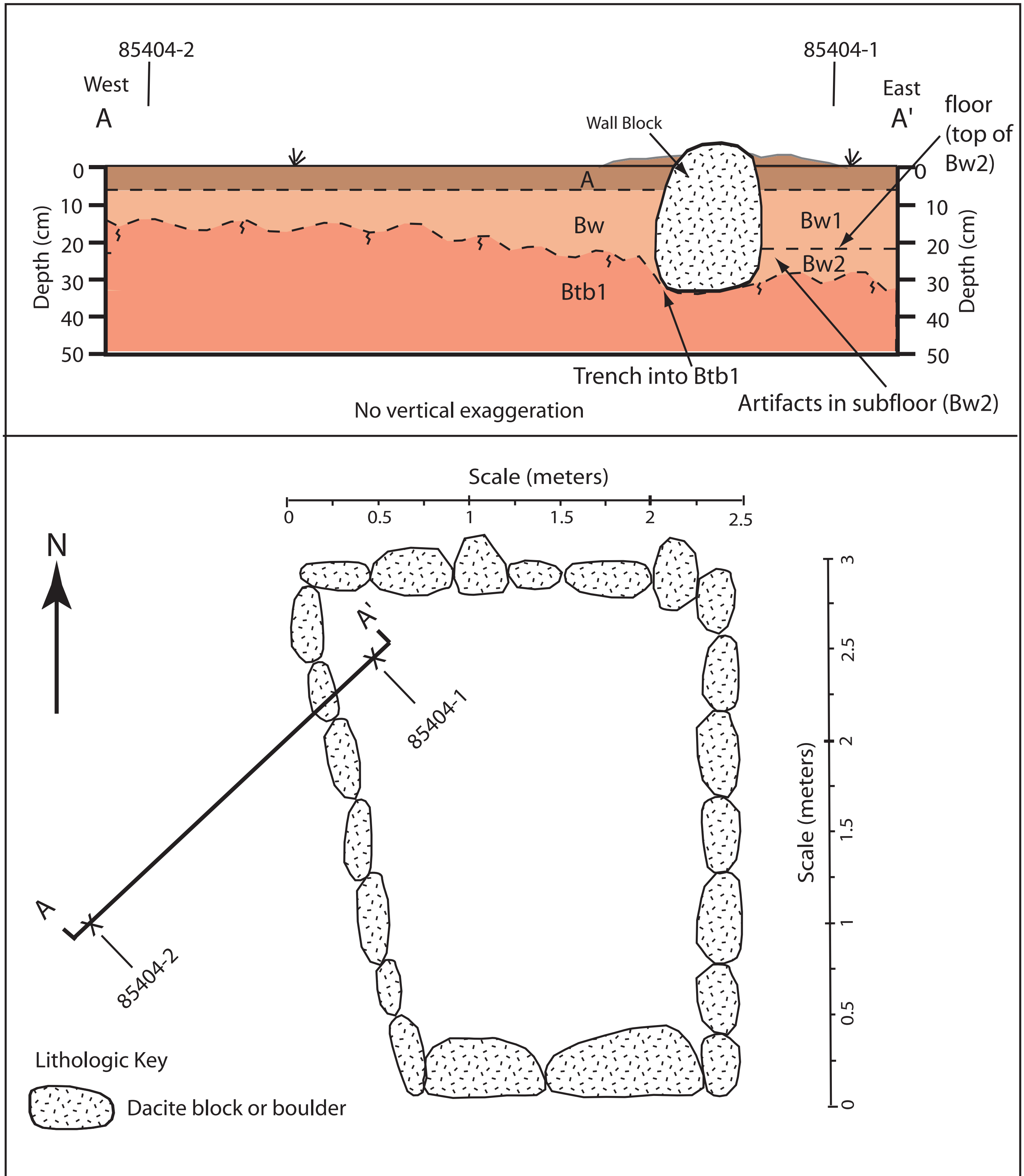
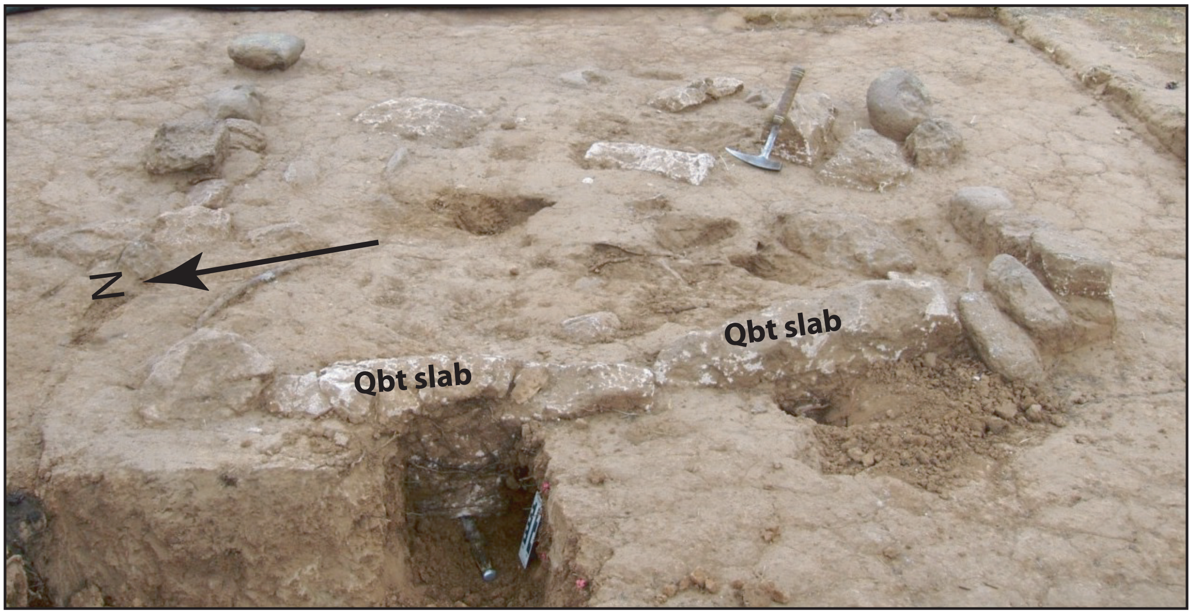


Figure 7. Schematic site map (plan view, bottom) and cross section (top), LA 85404.

Figure 8. Photographs showing fieldhouse constructed of large dacite boulders, archaeologists for scale (top) and soil stratigraphy at 85404-2 (102.6 N, 100E) (bottom), LA 85404.



Photograph of LA 86605 during excavation. Note Qbt slabs, opening in structure facing east.

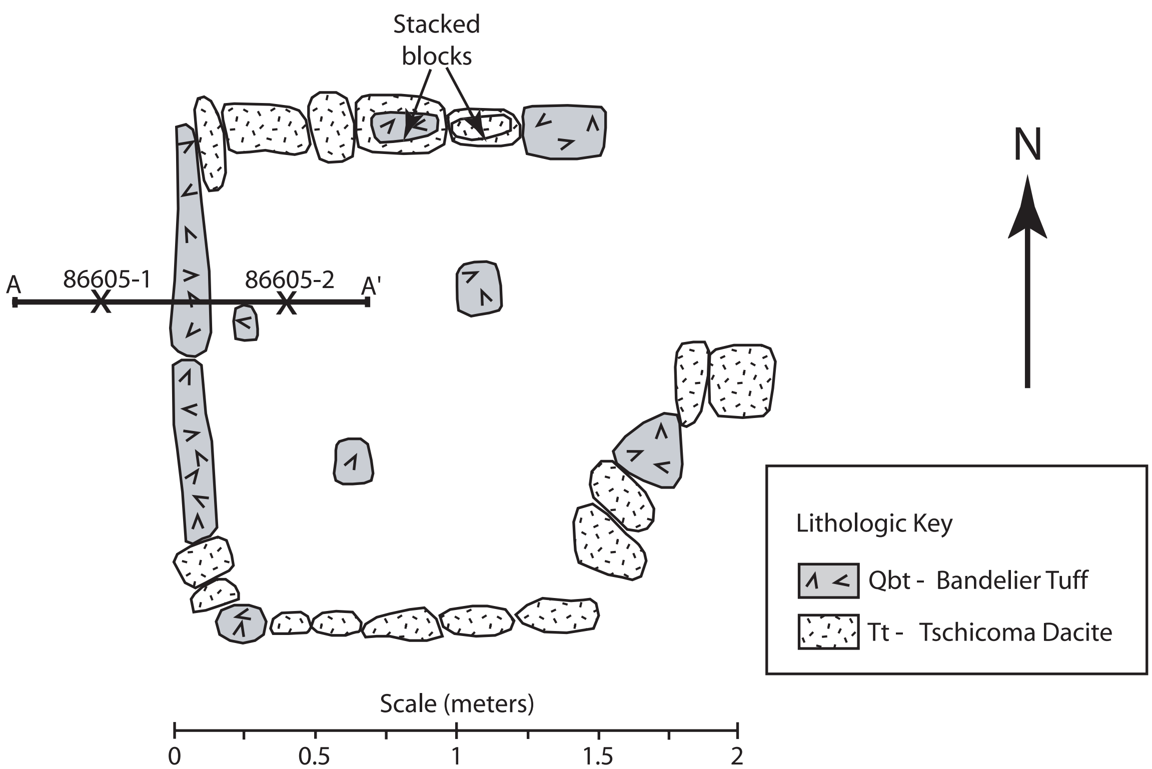
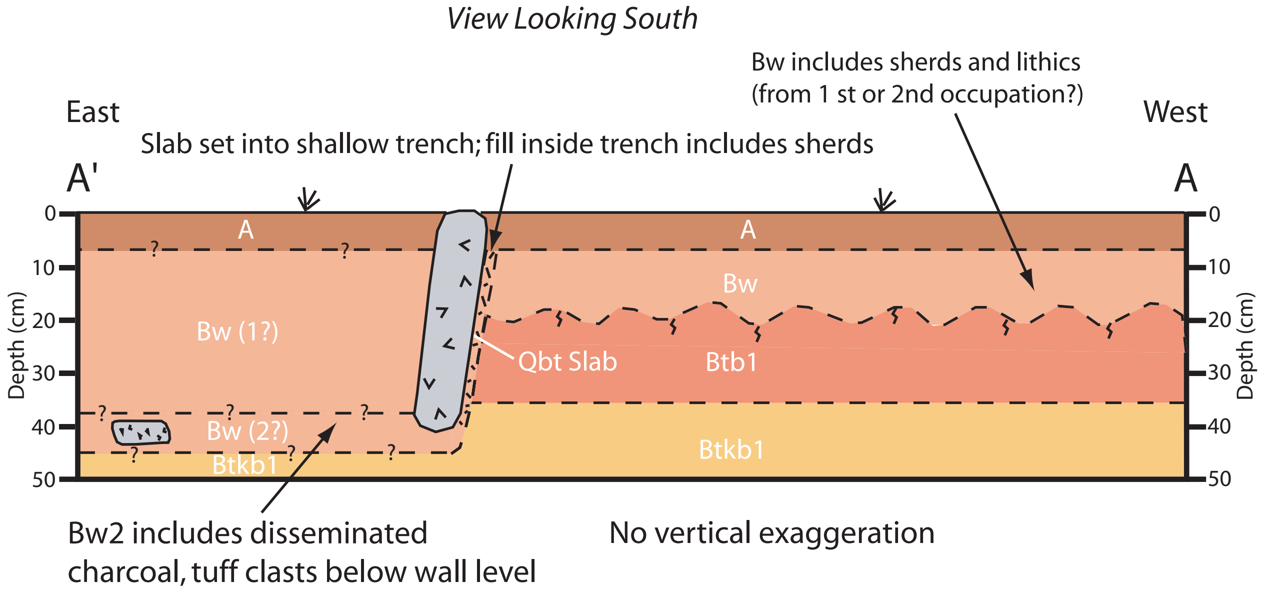


Figure 9. Schematic site map and photograph, LA 86605.



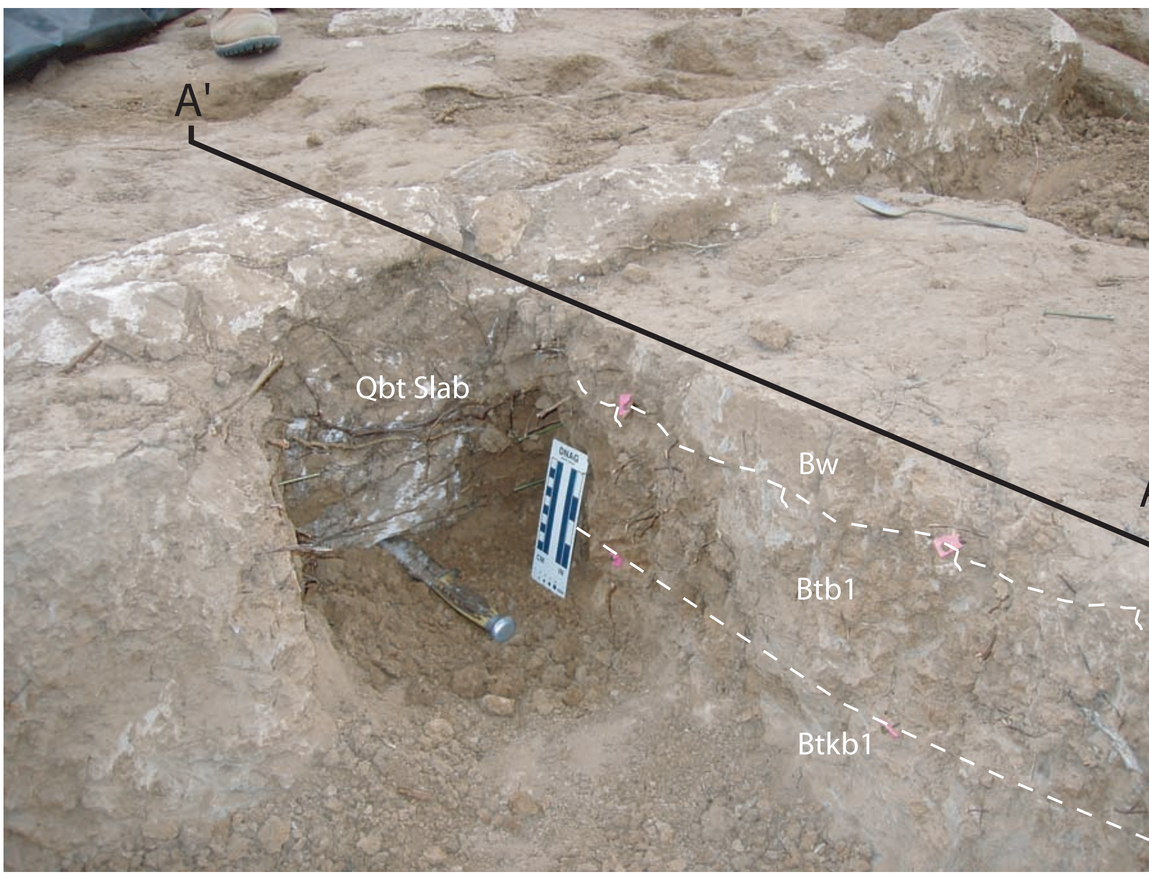


Figure 10. Photograph and cross-section (top), showing soil stratigraphy in relation to slabs used in wall construction , LA 86605. Note that cross section is drawn from east to west due to orientation of excavation.

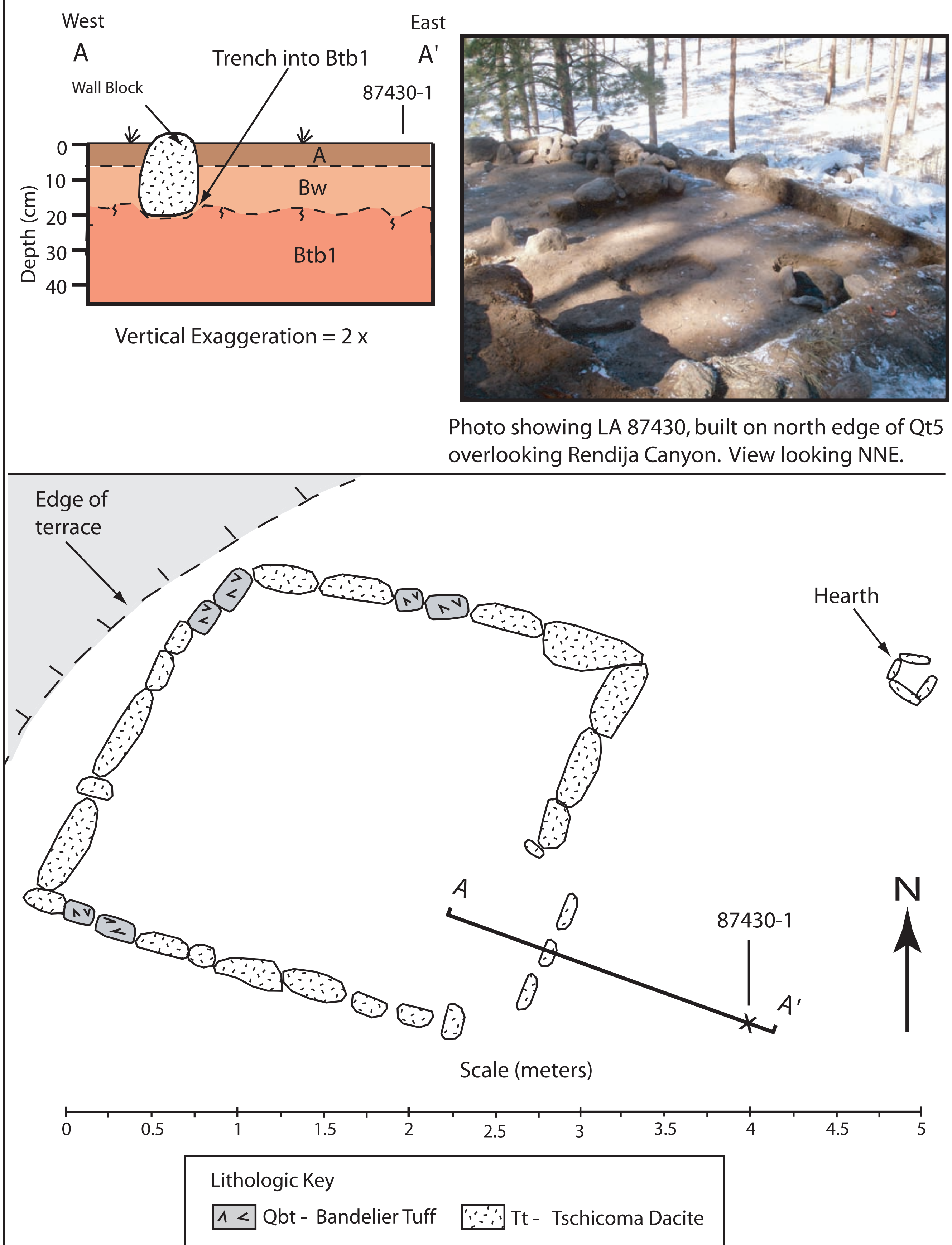


Photo showing LA 87430, built on north edge of Qt5 overlooking Rendija Canyon. View looking NNE.

Figure 11. Schematic site map (plan view, bottom) and cross section (top), LA 87430.

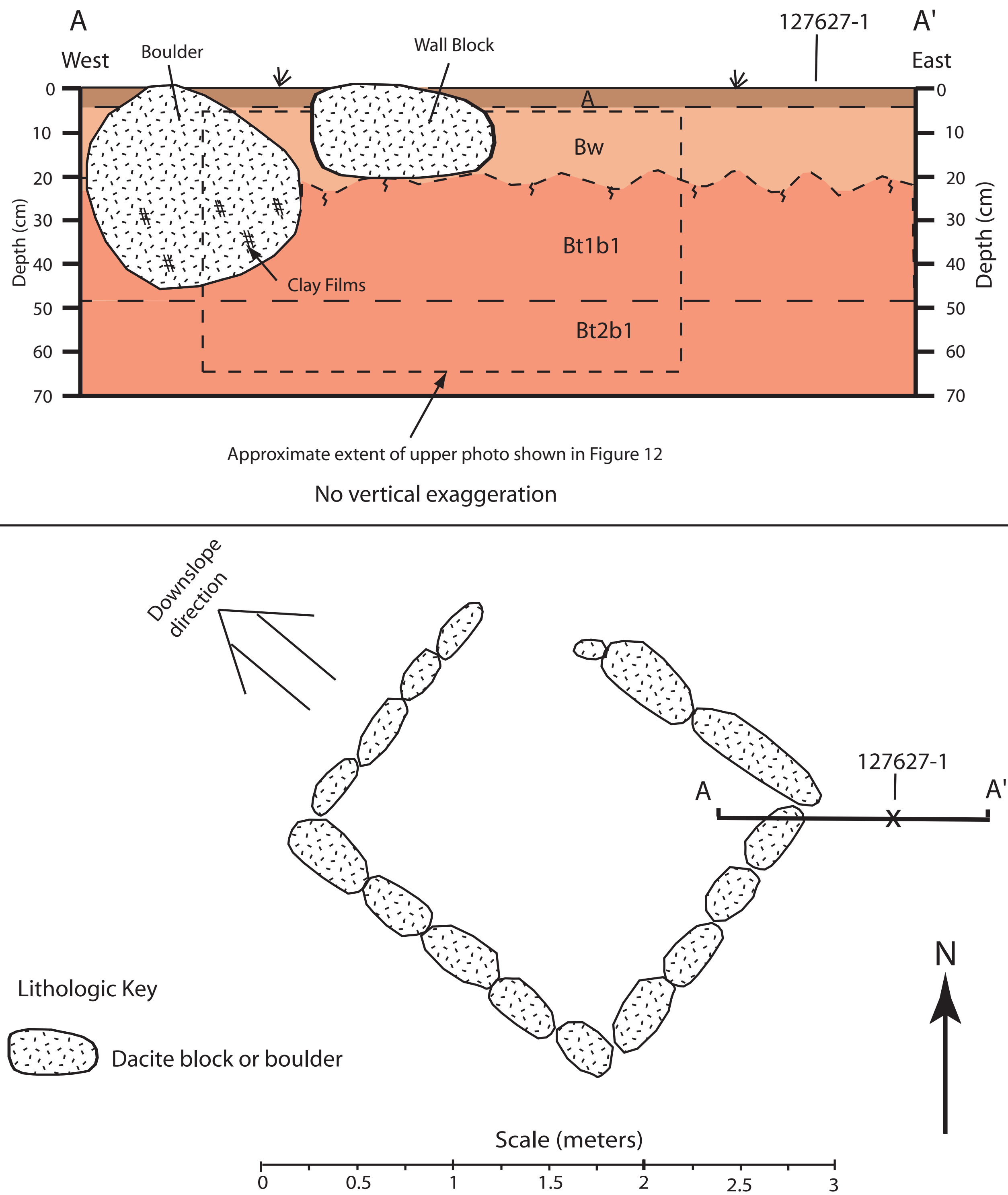


Figure 12. Schematic site map (plan view, bottom) and cross section (top), LA 127627.

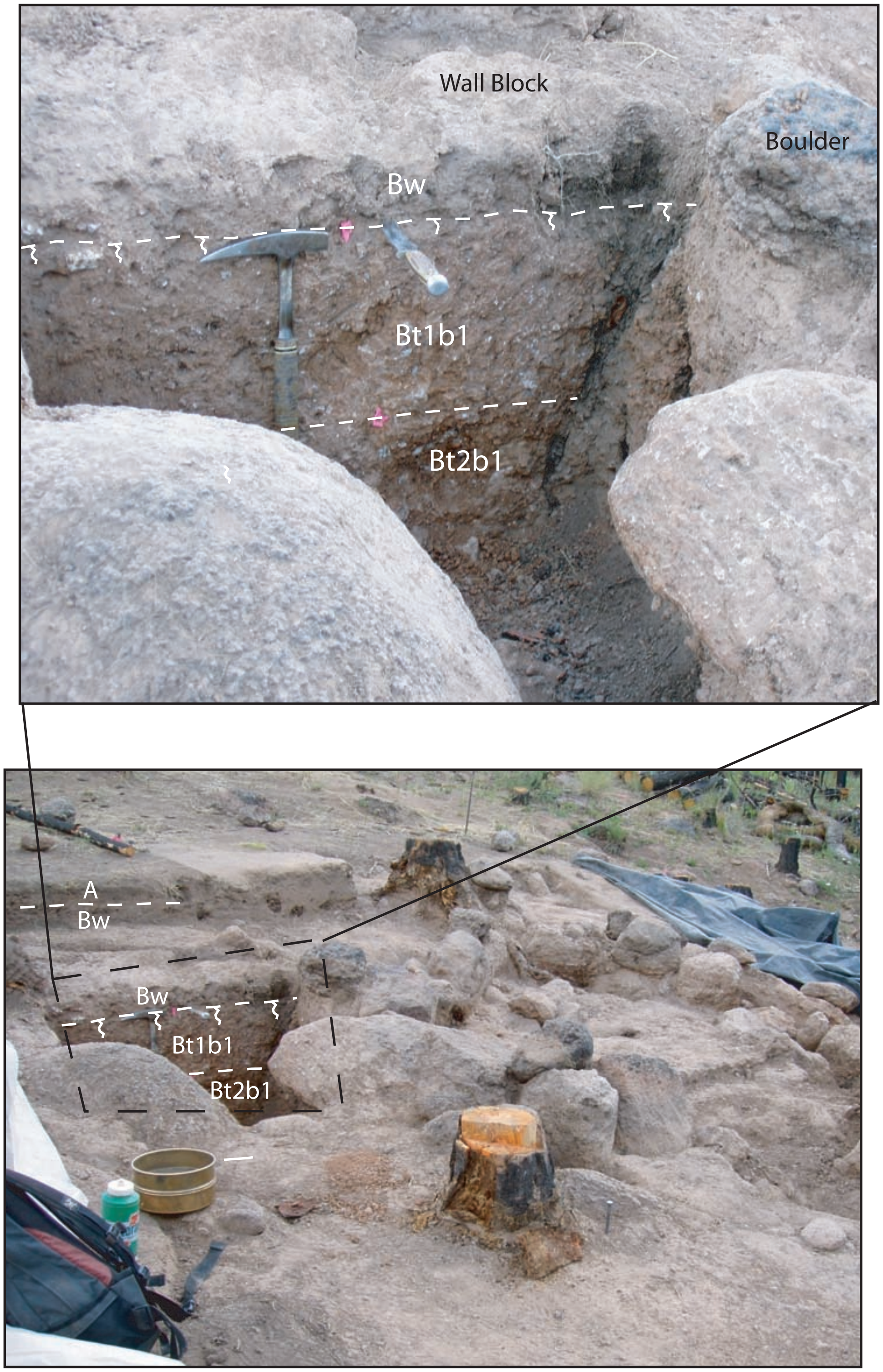
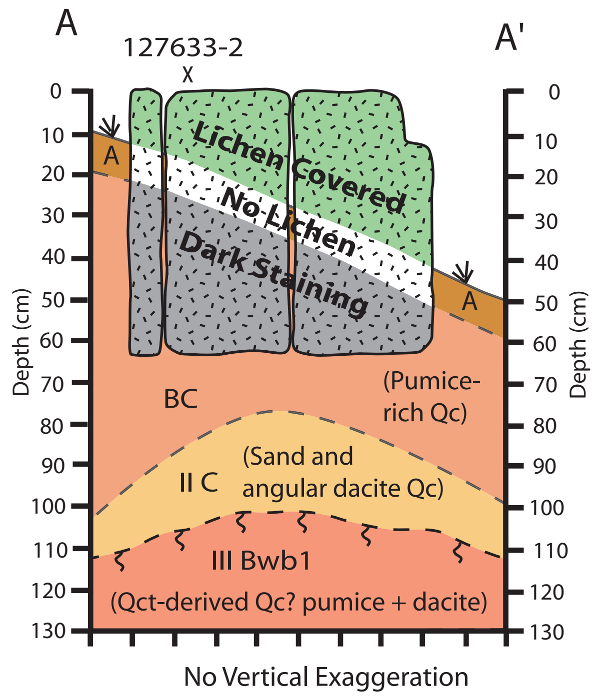


Figure 13. Photographs showing soil stratigraphy (top) and soil pit adjacent to wall blocks (bottom), LA 127627. View looking south.

Photo showing excavated upright dacite slabs and cross section line, LA 127633



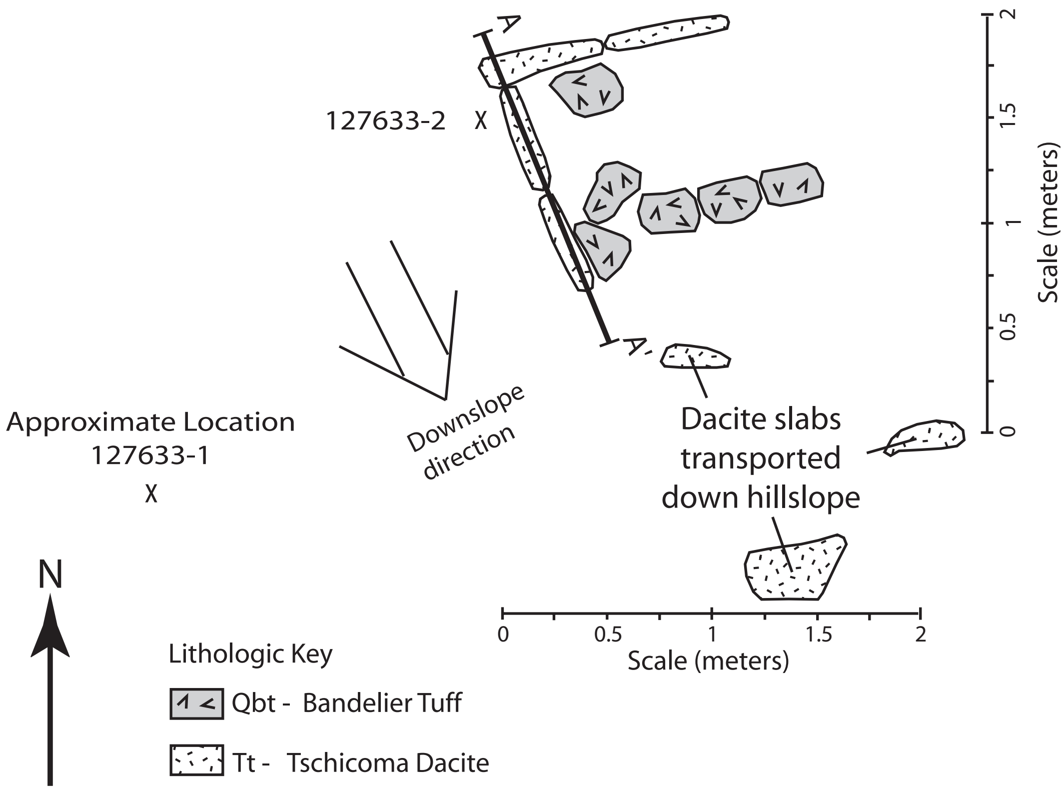
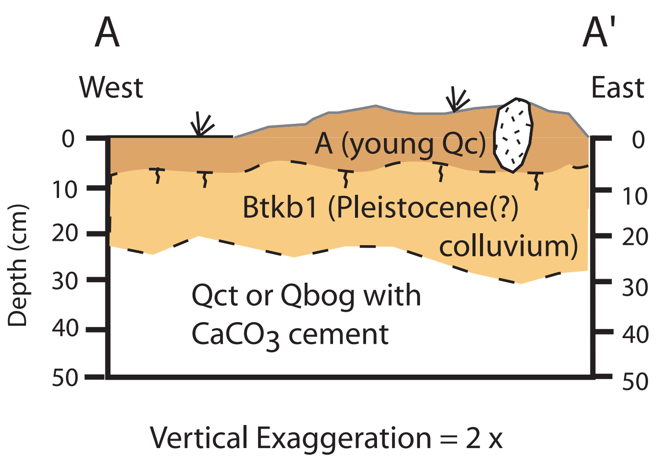


Figure 14. Schematic site map (plan view, bottom) and cross section (top), LA 127633.



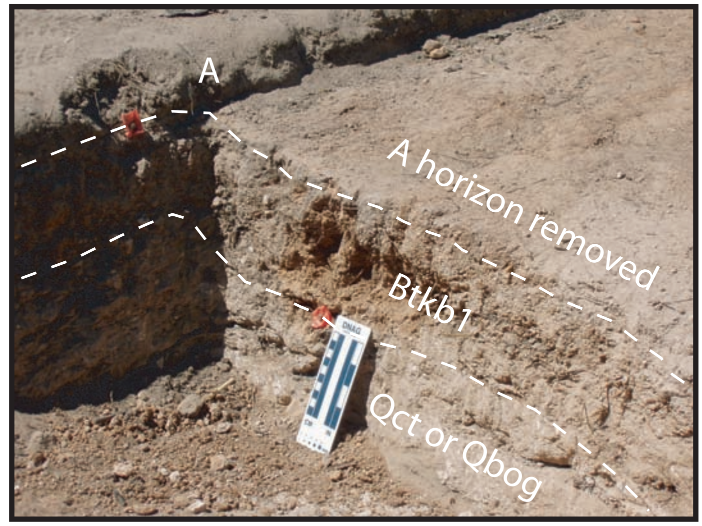


Photo showing soil stratigraphy at location 127634-1

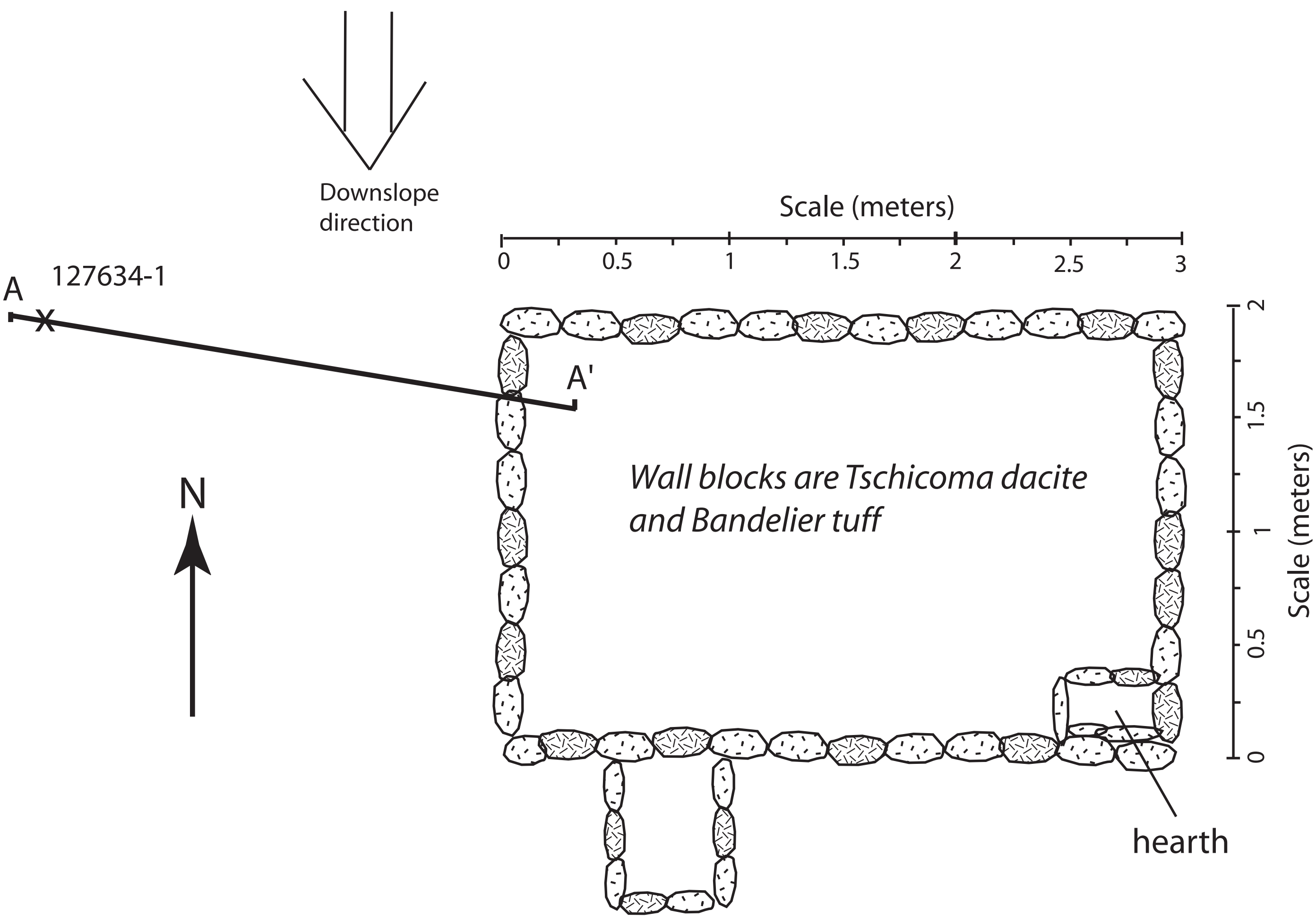


Figure 15. Schematic site map (plan view, bottom) and cross section (top), LA 127634.

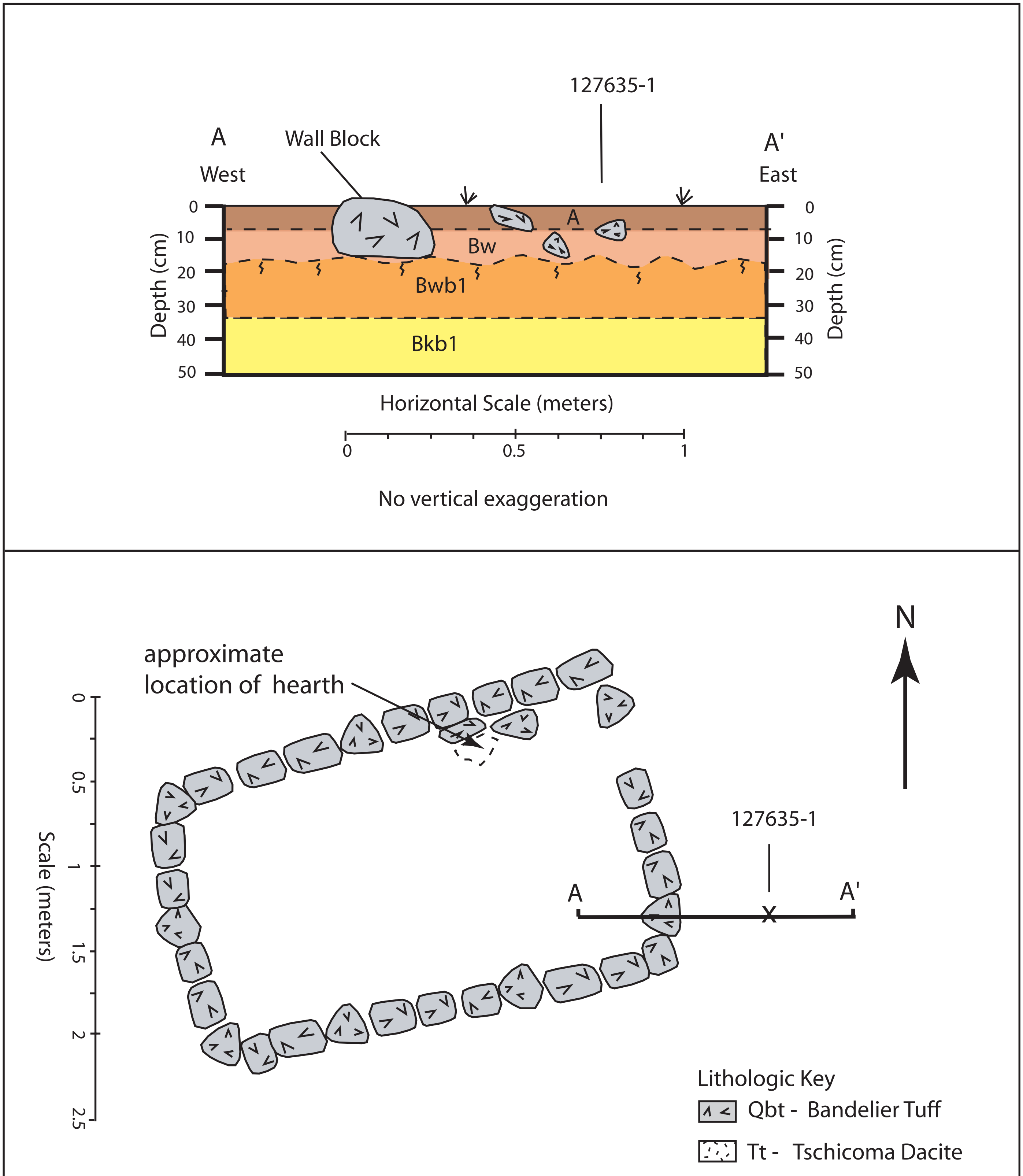


Figure 16. Schematic site map (plan view, bottom) and cross section (top), LA 127635.

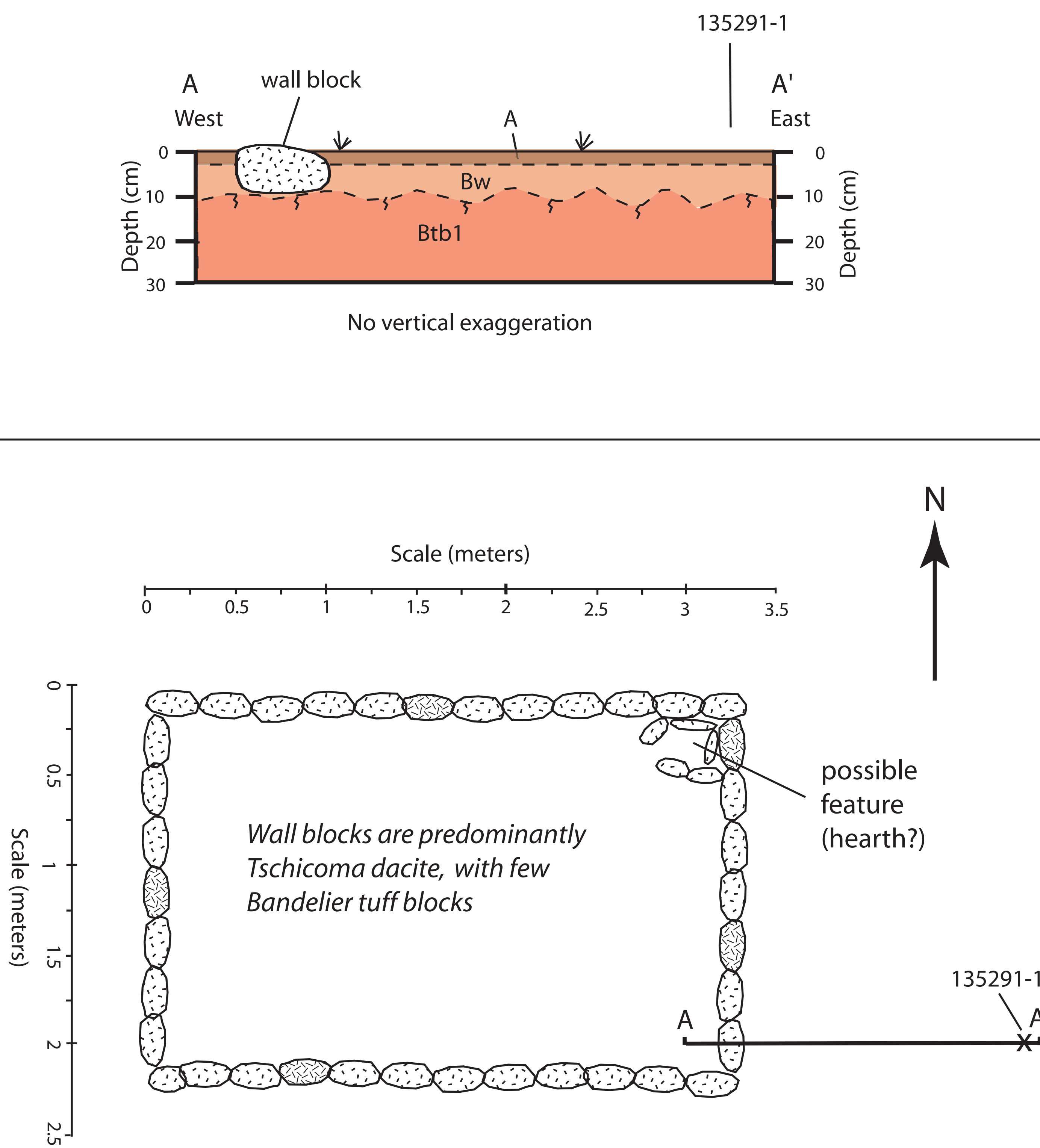


Figure 17. Schematic site map (plan view, bottom) and cross section (top), LA 135291.

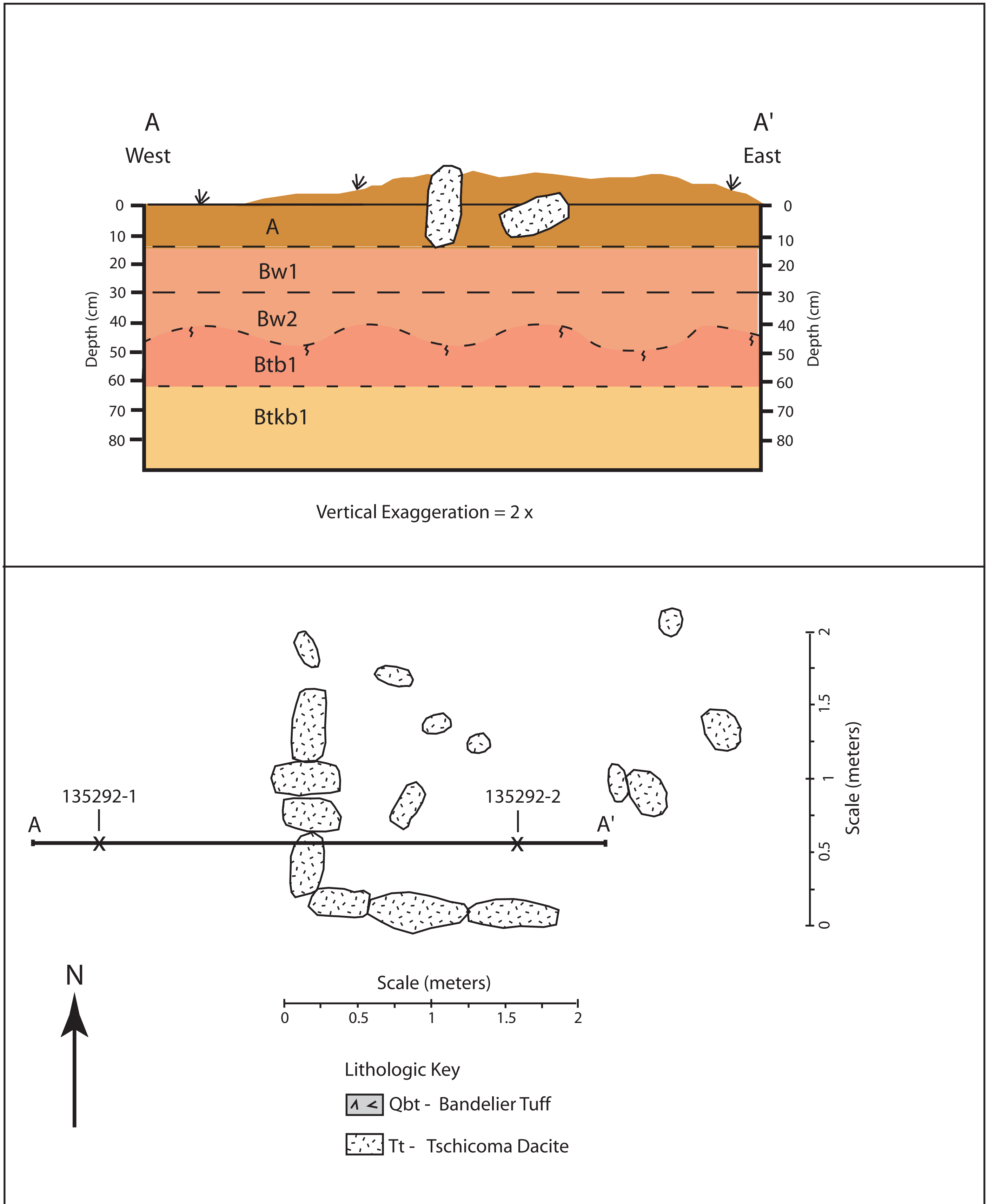


Figure 18. Schematic site map (plan view, bottom) and cross section (top), LA 135292.

TABLES

Table 1. Summary of soil morphology at Rendija Canyon land transfer sites, 2004 field season. Soils described by Paul Drakos and Steve Reneau.

Horizon	Depth (cm)	Gravel (%)	Dry Color (Matrix)	Moist Color (Matrix)	Texture	Structure	Dry Consist-ence	Wet Consist-ence	Argillans	CaCO3	CaCO3 Stage	Lower Horizon Boundary	Profile #	Preliminary Age Estimate (years BP)	Notes
LA 15116-1, Classic (?) period site, fieldhouse, N-facing slope below Qt2 surface; 1 m W. of west side of field house (July 6, 2004)													**15116-1**		
A	0-10	30-40	10YR5/3	10YR3/2	ls	1msbk	so-lo	so,po	n.o.	none	-	as		Late Holocene (<700 yrs?)	Includes dacite clasts; inferred wall fall
Bw	10-20	20	10YR6/3	10YR4/3	ls	2f-msbk	so	so,po	n.o.	none	-	as			Gravels include common pumice, possibly derived from weathered Qbo source
Btb1	20-40	30-40	7.5YR5/4	7.5YR3/4	ls	2msbk	so	so,po	1-2nco	none	-	aw		Early-Mid Holocene?	Possible reworking of older soil; charcoal bearing
Qbo?	40+														Whitish nonwelded tuff; Qbo or Qbt1g
LA 70025-1, Classic or Coalition (?) period field house, on disected Qc over Qt(?) ridge, 2m W of wall, 100N, 101.6E (December 3, 2004)															
A	0-5	2	10YR5/3	10YR3/3	ls	m	lo	so,po	n.o.	none	-	as		Late Holocene (<800 yrs?)	Qc
Bw1	5-14	<2	10YR4/3	10YR3/3	sl	1-2msbk	so	so,ps	n.o.	none	-	cs			
Bw2	14-29	5	10YR4/3	10YR3/3	scl	2msbk	so	ss,ps	n.o.	none	-	cs			post-occupation
Btjb1	29-40	2-5	10YR5/4	10YR3/3.5	scl	2fsbk	sh	ss,ps	1nbr	none	-	cs		Mid-Late Holocene?	pre-occupation
BC	40-50+	<1	10YR4/4	10YR3/4	sil	2msbk	so	ss,ps	n.o.	none	-	-			
LA 85403-1, Coalition or Classic (?) period field house, on Qt2 surface west of Sportsman's Club, 1.4m W of wall, 104.8N, 105E (Oct. 26, 2004)													**85403-1**		
A	0-9	10	10YR3/4	10YR3/3	sl	1fsbk	so-lo	so,po	n.o.	none	-	cs		Late Holocene (<800 yrs?)	Moist horizon [10YR5/3 dry?]
Bw	9-22	2-5	8.75YR3/4	8.75YR3/3	si	2msbk	so	ss,ps	n.o.	none	-	aw			Moist, eolian, post-occupation?
Bwb1	22-30+	2-5	7.5YR4/5	7.5YR3/4	si	2msbk	sh-h	ss,ps	n.o.	none	-	-			Some siltans, eolian
LA 85403-2, Coalition or Classic (?) period site, inside structure, below W. wall, 104.8N, 106.5E (Oct. 26, 2004)													**85403-2**		
Bwb1	30-35											as		Early-Mid Holocene?	Below wall; see Bwb1 description above
Btb1	35-50+	15.20	7.5YR4/5	7.5YR4/4	sic	2msbk	h	ss,p	1-2nbr	none	-	-			
LA 85404-1, Coalition or Classic (?) period field house, E-facing slope of Qt1 surface; inside fieldhouse, 104N, 102E (Sept. 21, 2004)													**85404-1**		
A	0-9	20-30	10YR4/3	10YR3/2	sl	1msbk→gr	so	so,po	n.o.	none	-	as		Late Holocene (<800 yrs?)	
Bw1	9-21	30	10YR5/3	10YR3/3	sl	2fsbk	so	so,po	n.o.	none	-	cs			
Bw2	21-30+	20	10YR5/3	10YR3/3	scl	2msbk	sh-h	ss,po	1nbrco (reworked peds?)	none	-	-			Possible floor preparation/reworking of older soil; charcoal bearing
LA 85404-2, Coalition or Classic (?) period field house, E-facing slope of Qt1 surface; 1.5m W of fieldhouse, 102.6N, 100E (Sept. 30, 2004)													**85404-2**		
A	0-6	20	10YR5/3	10YR3/3	sl	1-2fgr	so	so,po	n.o.	none	-	as		Late Holocene (<800 yrs?)	profile moist
Bw	6-12	40	10YR4/3	10YR3/3	sl	1-2msbk	so	so,po	n.o.	none	-	aw			some clay coatings on clasts (reworked gravels w/clay films), recycled from Bt horizon
Btb1	12-40+	70-80	7.5YR3/4	7.5YR3/4	scl	2msbk	h	s,p	3nkcopobrpf	none	-	-		Pleistocene	moist horizon
LA 86605-1, Coalition or Classic (?) site, field house; east-sloping shoulder of Qt2 (June 24, 2004)													**86605-1**		
Upper profile = 1.1m W of west wall (0-22 cm); lower profile = 0.5 m W of west wall															
A	0-7	5	10YR4/4	10YR3/3.5	ls	1-2msbk	so-sh	so,po	n.o.	none	-	as		Late Holocene (<800 yrs?)	very fine sand
Bw	7-19	<2	7.5YR4/4	7.5YR3/3	sil	2msbk	h	ss,ps	n.o.	none	-	cw			possible 1npobr; slopewash colluvium (Bwb1?); includes sherds and lithics
Btb1	19-35	<2	7.5YR5/4	7.5YR3/3.5	sil	2-3fabk	vh	ss,p	2npobrpf	none	-	cs		Late Pleistocene/Early Holocene	2pr breaking to 2-3msbk
Btkb1	35-50+	<2	7.5YR5/4	7.5YR4/4	sil	2mabk	vh	ss,ps	1npo	e-	I-	-			some CaCO3 filaments
Btkb1	54-93+														
LA 86605-2, Coalition or Classic (?) site, field house; east-sloping shoulder of Qt2 (June 24, 2004)													**86605-2**		
Profile described inside 1-room structure, approx. 0.4 m E of west wall; A horizon and upper part of Bw missing; base of Bw approx. 40 cm below top of tuff slab															
A	?														
Bw	? to 40-45	5-10	8.75YR4/3	7.5YR3/3	si	2msbk	sh	ss,ps	n.o.	none	-	as		Late Holocene (<800 yrs?)	charcoal scattered throughout, scattered Qbt clasts and granule to pebble size gravel (wall fall?); possibly includes baked soil, partly reddened
Btkb1	(40-45)+										I			Late Pleistocene/Early Holocene	CaCO3 coatings on ped faces plus filaments; Btk2b1?
LA 87430-1, Middle to late(?) Classic site, field house; north edge of Qt5, 102N, 102.5E, 1.8m E of structure (December 2, 2004)													**87430-1**		
"C"	+22-0														organic matter + loose sand (tree throw)
A	0-6	<2	10YR3/2	10YR2/1	sl	1msbk	so-lo	so,ps	n.o.	none	-	as		Late Holocene (<600 yrs?)	buried horizon
Bw	6-18	5-10	10YR4/3	10YR3/2	sl	1-2msbk	so	so,ps	n.o.	none	-	as			post-occupation
Btb1	18-41	5	10YR4/4	10YR3/4	scl	2msbk	so	ss,ps	1nbrpo	none	-	cs			pre-occupation, Qt5 soil(?)

Table 1. Summary of soil morphology at Rendija Canyon land transfer sites, 2004 field season. Soils described by Paul Drakos and Steve Reneau.

BCb1	41-54+	<5	10YR4/4	10YR3/3.5	scl	2f-msbk	so	ss,ps	n.o.	none	-	-			
LA 127627-1, Coalition or Classic period site, field house, N-facing slope below Qt2 surface, SE of SE (upslope) corner of fieldhouse (July 6, 2004)													**127627-1**		
A	0-5	10-20	10YR3/3	10YR2.5/2	sl	1msbk	so-lo	so,ps	n.o.	none	-	aw		Late Holocene (<800 yrs?)	Contains Cerro Grande ash and charcoal
Bw	5-21	20-30	10YR4.5/3	10YR3/3	sl	2msbk	h	so,po	n.o.	none	-	aw			siltans
Bt1b1	21-48	25	7.5YR4/4	7.5YR3/4	scl	2msbk	h	ss,ps	2ncopobr	none	-	cs		Late Pleistocene?	
Bt2b1	48-72+	60	7.5YR4/5	7.5YR3/4	scl	2fsbk	h	ss,po	2n-mkcopobr	none	-	-			Clayey sand is alternate texture
LA 127633-1, Slab lined feature, SE-facing slope Qc overlying Qct?, hillslope soil profile below (SW of) site (Sept. 30, 2004)													**127633-1**		
A	0-5	30	10YR5/3	10YR3/3	ls	m	lo	so,po!	n.o.	none	-	cs		Late Holocene (<600 yrs?)	
BC	5-57	20-30	10YR6/3	10YR3/4	ls	1fsbk-m	so-lo	so,po	n.o.	none	-	aw			late Holocene Qc
Btjb1	57-70+	20-30	7.5YR5/4	7.5YR4/3.5	sl	2msbk	so	ss,ps	1nco	none	-	-		Mid-Late Holocene	older Qc
LA 127633-2, Slab lined feature, SE-facing slope Qc overlying Qct?, west side of feature (December 21, 2004)													**127633-2**		
A	0-10														frozen; see profile 1 for description; historic Qc
BC	10-56	25	8.75YR5/3	8.75YR4/3	s	m	lo	so,po	n.o.	none	-	gs		Mid-Late Holocene	possible C horizon; young (Late Holocene) pumice-rich Qc
IIC	56-83	30-40	10YR4.5/4	10YR4/3	s	sg	lo	so,po	n.o.	none	-	aw			sand and angular dacite gravel
IIIBwb1	83-110+	20-30	7.5YR4/5	7.5YR4/4	ls	m	lo	so,po	n.o.	none	-	-		Mid-Late Holocene	Qct-derived Qc?; pumice-rich, some reworked with clay films?; 70% pumice, 30% dacite gravel
LA 127634-1, Classic period site, one-room structure with hearth set on Btkb1, on Qct or Qbog hillslope slopewash Qc, 2 m W. of wall, (Sept. 7, 2004)													**135292-1**		
A	0-6	10-20	10YR5/3	10YR3/3	ls	m	lo	so,po	n.o.	none	-	gw		Late Holocene (<600 yrs?)	young colluvium, post-occupation
Btkb1	6-23	30-40	7.5YR4/6	7.5YR4/4	scl	2f-msbk	so-sh	ss,ps	2nbr	e-	I-	aw		Late Pleistocene?	Pleistocene(?) colluvium, discontinuous CaCO3 coatings
IICBk	23-36+														Qct or Qbog w/CaCO3
LA 127635-1, Classic period site, field house situated on Qc wedge on the backside of pre-Qt6 terrace, 0.5 m E. of E. wall, 104.2N, 102E (Sept. 7, 2004)													**127635-1**		
A	0-7	20	10YR5/3	10YR3/3	ls	m	lo	so,po	n.o.	none	-	aw		Late Holocene (<800 yrs?)	young colluvium, post-occupation
Bw	7-19	10-20	10YR5/3.5	10YR3/3	sl	1-2msbk	sh	so,po	n.o.	none	-	cs			post-occupation colluvium with wall fall
Bwb1	19-33	2	8.75YR5/4	8.75YR4/3	scl	2msbk	sh	ss,ps	n.o.	none	-	aw		Mid to Late Holocene	top = likely occupation site
Bkb1	33-43+	5-10	8.75YR5/4	8.75YR4/5	scl	2m-csbk	h-vh	ss,ps	n.o.	es	I	-			filaments common on ped faces and interiors
LA 135291-1, Classic (?) period site, Qt2, N. slope, thin Qc + Qe over Bt, Profile 1= 1.6m E. of wall, 104N, 106.5E (Oct. 26, 2004)													**13529-1**		
A	0-4	5-10	10YR3/3	10YR2.5/2	sl	1fsbk	so-lo	so,ps	n.o.	none	-	cs		Late Holocene (<800 yrs?)	Possibly contains Cerro Grande ash
Bw	4-11	5-10	10YR3/4	10YR3/2	sl	1-2f-msbk	so	so,ps	n.o.	none	-	aw			Contains artifacts incuding biscuitware ceramics
Btb1	11-30+	30	7.5YR3/3	10YR3/2	sc	3fpr	h	s,p	3kpfpobrco	none	-	-		> 100 ka	>100 ka Bt
LA 135292-1, Classic period site, field house, on flat Qt2 surface overlain by slopewash Qc, 1.3 m W. of fieldhouse, N103, E101 (Sept. 7, 2004)													**135292-1**		
Lithics + ceramics, 0-30 cm															
A	0-14	5	10YR4/3	10YR3/3	sil	2fgr	so-sh	so,ps	n.o.	none	-	as		Late Holocene (<800 yrs?)	Peds commonly made of spheroids, crumbly
Bw1	14-30	2-5	10YR4/4	10YR3/3	sil	1-2msbk	so-sh	so,ps	n.o.	none	-	gs			horizon projects under structure
Bw2	30-44	2	10YR3.5/4	10YR3/4	si	1msbk	so	ss,ps	n.o.	none	-	aw			slopewash colluvium
Btb1	44-61	10-15	8.75YR4/4	8.75YR4/3	si	2msbk	sh	ss,ps	2nbrcopf	none	-	aw		Pleistocene	bioturbated soil above Qt2 gravels (Qc?)
Btkb1	61-70+	10	7.5YR3/3	7.5YR2.5/3	sicl	3m-cabk	h	ss,p	3-4ncopobrpf	e	I	-			discontinuous coatings on ped faces; abundant filaments on ped faces and in ped interiors
LA 135292-2, Classic period site, field house, inside structure, 103N, 101.8E (Sept. 7, 2004)													**135292-1**		
Lithics + ceramics, 0-30 cm															
A	0-28	20-30	10YR4.5/3	10YR3/3	sil	2mgr	sh	so,ps	n.o.	none	-	as		Late Holocene (<800 yrs?)	Room fill
Bw1	28-36+	2	10YR4/4	10YR3/3	sil	1-2msbk	so	so,ps	n.o.	none	-	-			Below wall level

Table 2. Field house site summary and relative age estimates, western Rendija Canyon land transfer sites, 2004 field season.

Site	Buried by (soil horizons and type of deposit overlying site)	Occupation surface and type of deposit	Depth of burial inside structure (cm)	Depth of burial outside structure (cm) and distance from wall (m)	Geomorphic setting/ comments	Estimated relative site age based on soils: 1 = youngest, 2 = intermediate, 3 = oldest	Notes on relative age estimates
LA 15116	A-Bw soil; Qc includes wall fall	Btb; Qc	7	20 cm, 1 m W	North-facing slope below Qt2 surface	2	intermediate age inferred based on A-Bw profile
LA 70025	A-Bw1-Bw2 soil; Qc	Btjb1; Qc	8	29 cm, 2 m W	On disected Qc slope over Qt ridge (?); Cabra Cyn	3? (2?) (1?)	relatively old age based on relatively thick post-occupation soil and A-Bw1-Bw2 profile outside; but thin eroded soil inside
LA 85403	A horizon only or A-Bw soil; Qe + Qc lag(?)	Bw or Bwb1; Qe	31	9 cm or 22 cm, 1.4 m W	On Qt2 surface	1? (3?)	young age inferred if Bw horizon is occupation surface; intermediate-old age inferred based on A-Bw profile, relatively thick soil on flat surface and slightly reddened Bw horizon
LA 85404	A-Bw soil outside; A-Bw1-Bw2 soil inside; Qc	Btb1;Qtg	32	12 cm, 1.5 m W	East-facing edge of Qt1	2? (3?)	intermediate age inferred based on relatively thin Bw profile outside structure, but relatively old age possible based on thicker A-Bw1-Bw2 profile inside
LA 86605 *first occupation*	A-Bw soil outside, A-Bw1-Bw2 soil inside; Qc (+ Qe?)	Btb1 (outside), Btkb1 (inside); Qc?	45	19 cm, 1.1m W	On east-sloping shoulder of Qt2; good evidence for two occupations; Includes Qbt slabs	3? (2?)	relatively old age inferred based on reddened color and relatively hard dry consistence of Bw horizon, possibly intermediate age based on A-Bw profile outside structure
LA 86605 *second occupation*	A horizon outside, A-Bw1 soil inside; Qc (+ Qe?)	Bw (outside), Bw2 (inside); Qc	38	7 cm, 1.1m W		1	relatively young age inferred based on trench for slab apparently cutting Bw horizon(?); thin overlying A horizon
LA 87430	A-Bw soil; Qc	Btb1; Qtg	23	18 cm, 1.8 m E	On north-edge of Qt5 above Rendija Cyn drainage	2? (1?)	intermediate age inferred based on A-Bw profile
LA 127627	A-Bw soil; Qc	Bt1b1; Qtg	13	21 cm, approx. 0.5 m E	On north-facing slope below Qt2	2? (3?)	intermediate age inferred based on A-Bw profile; possibility of relatively old age suggested by hard dry consistence of Bw horizon
LA 127633	A - BC soil; Qc slopewash	IIC; Qc	31	57 cm, hillslope profile SW of site	On relatively steep SE-facing slope; Qc overlying Qct? (storage bin)	1	young age inferred based on weak A-BC soil profile
LA 127634	A horizon; Qc slopewash	Btkb1; Qc	10	6 cm, 2 m W	On Qct or Qbog slopewash Qc	1	young age inferred based on thin and very weak post-occupation soil (A horizon)
LA 127635	A-Bw soil; Qc + wall fall	Bwb1; Qc	29	19 cm, 0.5 m E	On Qc wedge on back side of pre-Qt6 terrace	2? (1?) (3?)	intermediate age inferred based on A-Bw profile; possibility of relatively old age suggested by slightly hard dry consistence of Bw horizon
LA 135291	A-Bw soil; Qc+Qe	Btb1;Qtg	17	11 cm, 1.6 m E	North-facing slope below/on edge of Qt2 surface	2? (1?)	intermediate age inferred based on A-Bw profile; possibility of relatively young age suggested by thin post-occupation soil on gentle terrace top
LA 135292	A horizon; Qc slopewash	Bw1; Qc over Qtg	28	14 cm, 1.3 m W	On flat Qt2 surface overlain by slopewash Qc	1	young age inferred based on weak post-occupation soil profile (A horizon)

Table 3. Geomorphic position, slope, and fieldhouse orientations, western Rendija Canyon land transfer tract sites, 2004 field season

Site	Lithology of Blocks	Geomorphic setting/slope	Orientation of Structure	Comments
LA 15116	Tt Dacite dominates; minor Qbt Tuff	North-facing gentle slope below Qt2 surface	N-S x E-W	possible opening in E wall; structure oriented perpendicular to slope
LA 70025	Qbt Tuff+ Tt Dacite	On disected Qc slope over Qt ridge (?); Cabra Cyn	N20°W	Structure oriented to fit small ridge top
LA 85403	Tt Dacite	On broad, flat Qt2 surface	N-S x E-W	East-facing doorway
LA 85404	Tt Dacite	East-facing gently-sloping edge of Qt1	N-S x E-W	Non-rectangular strcuture; no obvious doorway
LA 86605	Qbt Tuff+ Tt Dacite	On broad, gently-sloping east-sloping Qt2 surface	N-S x E-W	East-facing doorway
LA 87430	Tt Dacite + Qbt Tuff	On north-edge of Qt5 above Rendija Cyn drainage	N20°E	Structure oriented to fit small terrace remnant; SSE-facing doorway
LA 127627	Tt Dacite	On northwest-facing slope below Qt2	N40°W	Structure oriented perpendicular to slope; door in NE corner
LA 127633	Tt Dacite slabs + Qbt Tuff blocks	On relatively steep (25°) SE-facing slope	N77°E	Structure oriented perpendicular to slope
LA 127634	Tt Dacite + Qbt Tuff	On south-facing Qct or Qbog slope	N-S x E-W	Structure oriented perpendicular to slope; south-facing entryway
LA 127635	Qbt Tuff	On Qc wedge on back side of pre-Qt6 terrace	N75°E	Structure oriented to fit small terrace remnant; NNE-facing doorway
LA 135291	Tt Dacite dominates; minor Qbt Tuff	N-facing slope below/ on narrow top of Qt2 surface	N-S x E-W	No obvious doorway
LA 135292	Tt Dacite	On flat Qt2 surface overlain by slopewash Qc	N-S x E-W	Structure not intact; doorway unknown

APPENDIX A

SOIL HORIZON NOMENCLATURE

APPENDIX A: SOIL HORIZON NOMENCLATURE

From Birkeland, 1999

DESCRIPTION OF MASTER HORIZON, HORIZON, AND SUBHORIZONS

O horizon—Surface accumulations of mainly organic material; may or may not be, or has been, saturated with water. Subdivided on the degree of decomposition as measured by the fiber content after the material is rubbed between the fingers.

Oi horizon—Least decomposed organic materials; rubbed fiber content is greater than 40% by volume.

Oe horizon—Intermediate degree of decomposition; rubbed fiber content is between 17 and 40% by volume.

Oa horizon—Most decomposed organic material; rubbed fiber content is les that 17% by volume.

A horizon—Accumulation of humified organic matter mixed with mineral fraction; the latter is dominant. Occurs at the surface or below an O horizon; Ap is used for those horizons disturbed by cultivation.

E horizon—Usually underlies an O or A horizon, and can be used for eluvial horizons within or between parts of the B horizon (e.g., common above fragipan, x). Characterized by less organic matter and/or fewer sesquioxides (compounds or iron and aluminum) and/or less clay than the underlying horizon. Many are marked by a concentration of sand and silt. Horizon is light colored due mainly to the color of the primary mineral grains because secondary coatings on the grains are absent; relative to the underlying horizon, color value will be higher or chroma will be lower.

B horizon—Underlies an O, A, or E horizon, and shows little or no evidence of the original sediment or rock structure. Several kinds of B horizons are recognized, some based on the kinds of materials illuviated into them, others on residual concentrations of materials.

Subdivisions are:

Bh horizon—Illuvial accumulation of amorphous organic matter-sesquioxide complexes that either coat grains or form sufficient coatings and pore fillings to cement the horizon.

Bhs horizon—Illuvial accumulation of amorphous organic matter-sesquioxide complexes, and sesquioxide component is significant; both color value and chroma are three or less.

Bk horizon—Illuvial accumulation of alkaline earth carbonates, mainly calcium carbonate; the properties do not meet those for the K horizon.

Bl horizon—Illuvial concentrations primarily of silt (Formal and Miller, 1984). Used when silt cap development reaches stages 5 and 6.

Bo horizon—Residual concentration of sesquioxides, the more soluble materials having been removed.

Bq horizon—Accumulation of secondary silica.

Bs horizon—Illuvial accumulation of amorphous organic matter-sesquioxide complexes if both color value and chroma are greater than three.

Bt horizon—Accumulation of silicate clay that has either formed in situ or is illuvial (clay translocated either within the horizon or into the horizon); hence it will have more clay than the assumed parent material and/or the overlying horizon. Illuvial clay can be recognized as grain coatings, bridges between grains, coatings on ped or grain surfaces or in pores, or thin, single or multiple near-horizontal descrete accumulation layers of pedogenic origin (clay bands or lamellae). In places, subsequent pedogenesis can destroy evidence of illuviaiton. Although Soil Survey Division Staff (1993) does not include this, clay accumulation that lacks evidence for illumiation is included (could have been formed in situ, for example).

Bw horizon—Development of color (redder hue or higher chroma relative to C) or structure, or both, with little or no apparent illuvial accumulation of material.

By horizon—Accumulation of secondary gypsum.

Bz horizon—Accumulation of salts more soluble than gypsum.

K horizon. A subsurface horizon so impregnated with carbonate that its morphology is determined by the carbonate (Gile and others, 1965). Authigenic carbonate coates or engulfs nearly all primary grains in a continuous medium. The uppermost part of a strongly developed horizon is laminated, brecciated, and/or pisolithic (Machette, 1985). The cemented horizon corresponds to some caliches and calcretes.

C horizon—A subsurface horizon, excluding R, like or unlike materials from which the soil formed, or is presumed to have formed. Lacks properties of A and B horizons, but includes materials in various stages of weathering.

Cox and Cu horizons—In many unconsolidated deposits, the C horizon consists of oxidized material overlying seemingly unweathered C. The oxidized C does not meet the requirement of the Bw horizon. In stratigraphy, it is important to differentiate between these two kinds of C horizons. Here Cox is used for oxidized C horizons and Cu for unweathered C horizons. Cu is from the nomenclature of England and Wales (Hodson, 1976). Alternatively the Cox can be termed BC or CB.

Cr horizon—In soils formed on bedrock, there commonly will be a zone of weathered rock between the soil and the underlying rock. If it can be shown that the weathered rock has formed in place, and has not been transported, it is designated Cr. Such material is the saprolite of geologist; in situ formation is demonstrated by preservation of original rock features, such as grain-to-grain texture, layering, or dikes. If such material has been moved, however, the original structural features of the rock are lost, and the transported material may be the C horizon for the overlying soil. Those Cr horizons with translocated clay, as shown by clay films, are termed Crt.

R horizon—Consolidated bedrock underlying soil.

Selected Subordinate Departures

Lower-case letters follow the master horizon designation. Those that are mainly specific to a particular master horizon are give above. Some can be found in a variety of horizons; they are listed below.

b Buried soil horizon with major features formed prior to burial. May be deeply buried and not affected by subsequent pedogenesis; if shallow, they can be part of a younger soil profile.

c Concretion or nodules cemented by accumulations of iron, aluminum, magnaneses, or titanium.

f Horizon cemented by permanent ice. Seasonally frozen horizons are not included, nor is dry permafrost material (material that lacks ice but is colder than 0ºC).

g Horizon in which gleying is a dominant process, that is, either iron has been removed during soil formation or saturation with stagnant water has preserved a reduced state. Common to these soils are neutral colors, with or without mottling. Most have chromas of 2 or less and many have redox concentrations. Strong gleying is indicated by chromas of one or less, and hues bluer than 10Y. Much of the above color is due to the color of reduced iron, or the color of uncoated grains from which iron pigment has been removed. Bg is used for horizons with pedogenic features in addition to gleying; however, if gleying is the only pedogenic feature, the horizon is designated Cg.

j Used in combination with other horizon designation (Btj, Ej) to denote incipient development of that particular feature or property (National Soil Survey Committee of Canada, 1974). A rule for some designations would be to use it for those horizons that do not meet criteria for diagnostic horizons (e.g., Ej for an eluvial horizon that does not meet the criteria of the albic horizon).

k Accumulation of alkaline earth carbonates, commonly $CaCO_3$.

m Horizon that is more than 90% commented. Denote the cementing material (Km, carbonate; qm, silica; Kqm, carbonate and silica; etc.).

n Accumulation of exchangeable sodium.

ss Presence of slickensides.

v Has two uses. (1) One is plinthite, iron-rich, humus-poor, reddish material that hardens irreversibly when dried. (2) If A horizons in arid environments have a vesicular structure (round voids), they are designated Av (McFadden, 1988).

x Subsurface horizon characterized commonly by a bulk density greater than that of the adjacent horizons, firmness and brittleness, and very coarse prismatic structure with bleached vertical faces (fragipan character). An E horizon may oerlie the fragipan horizon at depth as well as between the A and Bt horizons higher in the profile. If the E-horizon nomenclature designations are identical, and both are pedogenic, a prime is applied to the lower E horizon. In this example, the profile would be A/E/Bt/E'/Bx/Cox.

y accumulation of gypsum.

z Accumulation of salts more soluble that gypsum (e.g., NaCl).

APPENDIX B

Key to symbols used in descriptions of soil morphology

APPENDIX B: Key to symbols used in descriptions of soil morphology (from Birkeland (1984) and McDonald (1996))

Structure

Grade	**Size**	**Type**	**Other**
1 = weak	vc = very coarse	sbk = subangular blocky	: = parting to (e.g. pr:pf)
2 = moderate	c = coarse	abk = angular blocky	
3 = strong	m = medium	pr = prismatic	
	f = fine	pl = platy	
		sg = single grain	
		m = massive	

Consistence

Dry	**Moist**	**Wet - Stickiness**	**Wet - Plasticity**
lo = loose	lo = loose	so = non sticky	po = non-plastic
so = soft	vfr = very friable	vss = very slightly sticky	vps = very slightly plastic
sh = slightly hard	fr = friable	ss = sticky	ps = slightly plastic
h = hard	fi = firm	s = sticky	p = plastic
vh = very hard	vfi = very firm		

Cutans

Abundance	**Thickness/(Distinctness)**	**Location/Type**	**Type**
n.o. = none observed	n = thin (faint)	po = along pores	man = mangans
v1 = very few (< 5%)	mk = moderately thick (distinct)	co = coating gravel, ped faces	skel = skeletons
1 = few (2 - 25%)	k = thick (prominent)	br = bridging grains	si = silans
2 = common (25 - 50%)		pf = along ped faces (as co + br)	
3 = many (50 - 75%)		pr:pf along prismatic ped faces	
4=near continuous (75+%)		bk:pf on blocky ped faces	
		Lam = lamellae	
		Non-lam = interspace between lamellae	
		PI: ped interior	
		prfc: pressure faces	
		irg = irregular shape	

Horizon Boundary

Thickness	**Topography**	**Carbonate effervescence in HCl**
a =abrupt (< 2.5cm)	s = smooth	none = non-effervescent
c = clear (2.5 - 6cm)	w = wavy	e = slightly effervescent
g = gradual (6-12.5cm)	i = irregular	es = strongly effervescent
d = diffuse (> 12.5 cm)	b = broken	ev = violently effervescent
		e- = very slightly effervescent

Texture

s = sand	sil = silt loam
ls = loamy sand	scl = sandy clay loam
sl = sandy loam	sicl = silty clay loam
l = loam	cl = clay loam

APPENDIX C

Soil properties utilized in field descriptions

From Birkeland (1999), Appendix A, and Table 1.3

Structure

Describe type, grade, and structure size. If the structure is not apparent, take a spade full of the soil and tap it horizontally on the ground and look for repeating patterns.

Type of Structure: Use Table 1.3 to define the type of soil structure.

Grade:

m—massive. Enough aggregation to maintain a vertical face but no formation of structure type (structureless).

sg—single grain. No aggregation (structureless). Loose grains of a sand dune are a good example.

1—weak. Peds barely observable in place, and, when disturbed, few entire peds are observed; much of the material is unaggregated.

2—moderate. Peds easily observable in place. When disturbed, there is a mixture of whole peds, broken peds, and some material not organized into peds.

3—strong. Peds are distinctly visible in place, and, when disturbed, nearly the entire mass consists of whole peds.

Size: Size differs with the kind of structure as shown in Table A1.4. Smaller structural units may be held together in such a way as to form larger units. For example, small subangular blocky units may combine in such a way to form larger prismatic units. The dominant structure is the primary structure when calculating PDI values, and the subordinate structure is the secondary structure.

Table 1.3 Description and Probable Origin of Soil Structure

Type	Sketch[a] and Description	Probable Origin[b]	Usual Associated Soil Horizon
Granular	 Spheroidally shaped aggregates with faces that do not accommodate adjoining ped faces	Colloids, mainly organic, bind the particles together; clay and Fe and Al hydroxides may be responsible for some binding, and flocculating capacity of some ions, such as Ca^{2+}, may be helpful; periodic dehydration helps form more stable aggregates	A
Angular blocky *Subangular blocky*	  Approximately equidimensional blocks with planar faces that are accommodated to adjoining ped faces; face intersections are sharp with angular blocky, rounded with subangular blocky	Many faces may be intersecting shear planes developed during swelling and shrinkage that accompany changes in soil moisture	Bt
Prismatic *Columnar*	 Particles are arranged about a vertical line, and ped is bounded by planar vertical faces that accommodate adjoining faces; prismatic has a flat top, and columnar a rounded top.	Faces develop as a result of tensional forces during times of dehydration; rounded column tops may be due to some combination of erosion by percolating water and greater amounts of upward swelling of column centers on wetting	Bt Bn
Platy	 Particles are arranged about a inherited horizontal plane	May be related to particle size orientation from parent material or induced by freeze–thaw processes	E, or those with fragipan
		May be related to layering in cementing material, induced during its precipitation(carbonate, silica, Fe hydroxides)	Km, Bqm, Bs

[a]Taken from Soil Survey Staff (1975).

[b]From Baver (1956), Black (1957), Rode (1962), and White (1966).

Gravel Content

Estimate volume percentage occupied by gravel (>2 mm). Weight percentage can be determined in the field with a screen (one can use an inexpensive 3-mm door screen) and a hand-held portable scale. Be watchful for shape and lithologic changes during the screening process, as they may indicate parent materials of more than one origin.

Consistence

Consistence is a measure of the adherence of the soil particles to the fingers, the cohesion of soil particles to one another, and the resistance of the soil mass to deformation. Soil Survey Division Staff (1993) has changed some of the terms, but the older terms are kept here as PDI values are based on them. Because this property varies with moisture content, it is taken when the soil is dry, moist, and wet. The wet consistence (natural or artificial wetness) is useful in determining texture classes in the field.

Dry Consistence (naturally dry in exposure):

lo—loose. Noncoherent, such as grains of a sand dune.
so—soft. Easily fails to powder or single grain, with very slight force between thumb and forefinger.
sh—slightly hard. Easily fails under slight force between thumb and forefinger.
h—hard. Fails in the hands without difficulty; requires strong force to fail between thumb and forefinger.
vh—very hard. Fails in hands with difficulty, but not between thumb and forefinger.
eh—extremely hard. Cannot be failed in hands.

Moist Consistence (usual moisture when one digs back into exposure):

lo—loose. Noncoherent.
vfr—very friable. Easily fails to powder or single grain, with very slight force between thumb and forefinger.
fr—friable. Fails under slight force between thumb and forefinger.
fi—firm. Fails under moderate force between thumb and forefinger.
vfi—very firm. Fails under strong force between thumb and forefinger.
efi—extremely firm. Fails under very strong force between hands but cannot be crushed between thumb and forefinger.

Wet Consistence (usually wetted artificially, but not so much the mass flows):

Stickiness is measured by pressing the wet soil between the thumb and forefinger and noting its adherence.

so—nonsticky. Practically no adherence to thumb and forefinger when pressure released.
ss—slightly sticky. After release of pressure, soil adheres to both thumb and forefinger but comes off one or the other rather cleanly. Does not appreciably stretch.
s—sticky. After release of pressure, soil adheres to both thumb and forefinger and tends to stretch somewhat before pulling apart from either digit.
vs—very sticky. After release of pressure, soil adheres strongly to both digits and is markedly stretched when they are separated.

Table A1.4 Classes of Soil Structure

0 20 40
Scale (in mm)

Size Class	Diameter of Granules (mm)	Thickness of Plates (mm)	Diameter of Blocks (mm)	Diameter of Prisms (mm)
vf—very fine	<1	<1	<5	<10
f—fine	1–2	1–2	5–10	10–20
m—medium	2–5	2–5	10–20	20–50
c—coarse	5—10	5–10	20–50	50–100
vc—very coarse	>10	>10	>50	>100

Plasticity is measured by rolling the wet soil between the thumb and forefinger and observing whether a roll can be formed and maintained.

po—nonplastic. No roll can be formed.

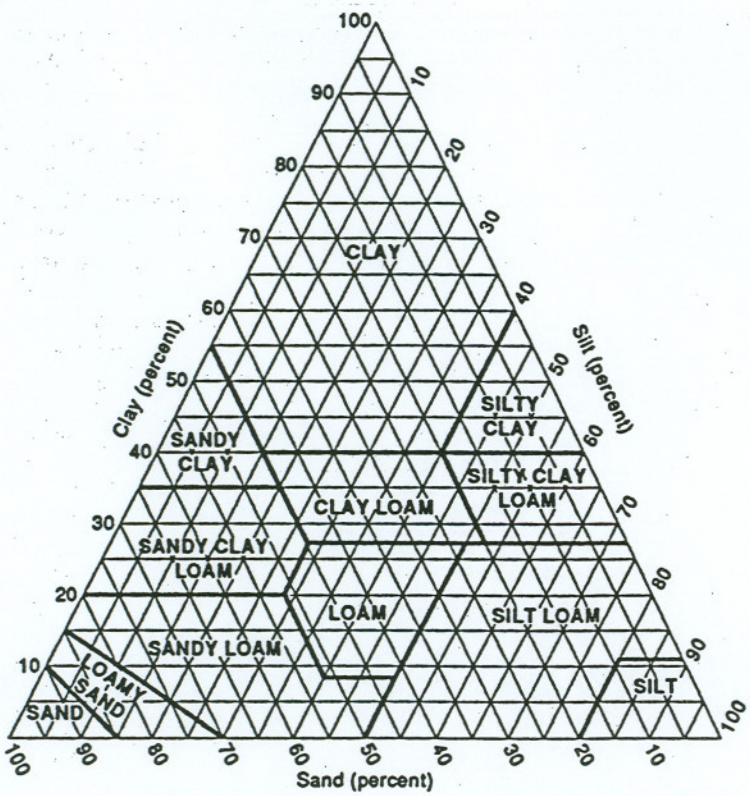
ps—slightly plastic. A roll 4 cm long and 6 mm thick can be formed and, if held on end, will support its own weight. A 4-mm-thick roll will not support its own weight. The roll is easily deformed and broken.

p—plastic. A roll 4 cm long and 4 mm thick can be formed and support its own weight. A 2-mm-thick roll will not support its own weight.

vp—very plastic. A roll 4 cm long and 2 mm thick can be formed and support its own weight. The roll is readily bent into a half or full circle.

Texture

Use established names from the textural triangle (Fig. A1.3). Screen out gravels and determine the textural class of the <2-mm fraction by noting the grittiness and wet consistence as shown in Fig. A1.4 (see also useful table of properties in Foss and others, 1975). Broad guidelines are given in the figure, but for more accuracy one should calibrate one's fingers by texturing samples with known particle-size distribution.



TEXTURAL ABBREVIATIONS:			
C	Clay	SCL	Sandy Clay Loam
CL	Clay Loam	SL	Sandy Loam
L	Loam	Si	Silt
LS	Loamy Sand	SiC	Silty Clay
S	Sand	SiCL	Silty Clay Loam
SC	Sandy Clay	SiL	Silt Loam

MODIFIER ABBREVIATIONS:	
vf	very fine
f	fine
co	coarse
vco	very coarse
g	gravelly

Figure A1.3 Textural names and abbreviations of names versus sand–silt–clay contents. *(Redrawn from Soil Survey Division Staff, 1993, Fig. 3.16.)*

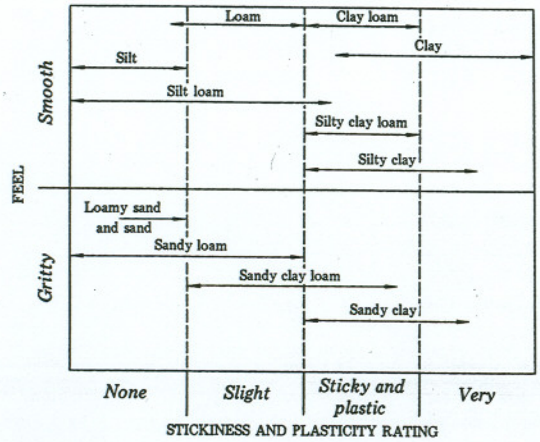


Figure A1.4 Approximate relations between texture class, grittiness, and wet consistence.

Clay Films

Clay films are thin layers of oriented clay and are described by recording their amount, distinctness, and locations. Study the peds with a hand lens in the field, or with a binocular microscope in the laboratory.

Amount:

v1—very few. Occupies less than 5% of the total area of the kind of surface described.

1—few. Occupies 5–25% of the total area of the kind of surface described.

2—common. Occupies 25–50% of the total area of the kind of surface described.

3—many. Occupies more than 50% of the total area of the kind of surface described.

The same classes are used to describe the amount of bridges connecting particles of structureless soil bodies. The amount is judged on the basis of the percentage of particles of the size designated that are joined to adjacent particles of similar size by bridges at contact points.

Distinctness: Distinctness refers to the ease and degree of certainty with which a surface feature can be identified. Distinctness is related to thickness, color contrast with the adjacent material, and other properties, but is not itself a measure of any one of them. Some thick films, for example, are faint, whereas some thin ones are prominent. The distinctness of some surface features changes markedly as the amount of moisture changes; therefore, the soil-water state might be specified. Clay films are difficult to recognize in wet soils. If classifying films on ped faces, compare features on a ped face with those on a nonstructural face broken across the ped. Three distinctness classes are used.

f—faint. Evident only on close examination with 10× magnification and cannot be identified positively in all places without greater magnification. The contrast with the adjacent material in color, texture, and other properties is small.

d—distinct. Can be detected without magnification, although magnification or tests may be needed for positive identification. The feature contrasts enough with the adjacent material that a difference in color, texture, or other properties is evident.

p—prominent. Conspicuous without magnification when compared with a surface broken through the soil. Color, texture, or some other property or combination of properties contrasts sharply with properties of the adjacent material, or the feature is thick enough to be conspicuous.

Location of Clay Films: Oriented clay is present as films on peds, inside of pores, or as bridges between grains and coats on grains. If films are preferential to some orientation (horizontal vs vertical), this should be noted.

pf—clay films occur on ped faces. Where the structure grade is weak or the soil is structureless, ped faces are indistinct or absent. It is probable that only when the structure grade is moderate or strong are the clay films on ped faces discernible.

po—clay films line tubular or interstitial pores.

br—oriented clay occurs as bridges holding mineral grains together. This is probably an initial step that occurs before clay films coat grains and is best observed in coarse-textured soils.

co—colloid coats mineral grains.

cobr—coats and bridges are present. This is probably more common than coats or bridges alone.

In describing clay films, care must be exercised not to confuse pressure faces with clay films. The former are common in soils with high clay content (Vertisols; shrink–swell clay such as smectite is best), and seasonal wetting and drying. Pressure faces arise when swelling pushes structural aggregates together and makes their sides smooth and, in places, reflective. At times these are difficult to differentiate from clay films, but some clay films can also be partly pressure faces. Slickensides are produced in the same manner, but are better developed, being polished and striated, and usually at >50 cm depth. Where slickensides are prominent, they are extensive and oriented at 20–30° from the horizontal to form wedges (Ahmad, 1983). If the shrinking and swelling that produce slickensides are extensive enough, wide and deep ground cracks will form during the dry season.

Examples of Clay-Film Descriptions:

3d po—many distinct clay films in pores.
2f pf and po—common faint clay films on peds and in pores.
3p pf, 2f po—many prominent clay films on ped faces, common faint clay films in pores.

It is important to record clay films because their presence is strong evidence for pedogenically illuviated clay. However, be warned that in places clay films can be original depositional (parent material) features. Waters charged with fine sediment that infiltrate a flood plain can produce clay films at depth (Walker and others, 1978), as can similar waters infiltrating till at the base of a glacier. If these latter parent-material films are present below the main soil-forming zone, their color will be closer to that of the parent material than to that of the soil.

Horizon Boundaries

Describe the lower boundary of each horizon, indicating distinctness and general topography.

Distinctness:

a—abrupt. Transition is less than 2 cm.
c—clear. Transition is 2–5 cm thick.
g—gradual. Transition is 5–15 cm thick.
d—diffuse. Transition is more than 15 cm thick.

Topography: Topography refers to the nature of the surface that separates the horizons. The modifiers sl (slightly) and v (very) may be used in combination with the following abbreviations.

s—smooth. Boundary is planar or parallel to the geomorphic surface.
w—wavy. Undulating surface with pockets wider than they are deep.
i—irregular. If pockets are deeper than their width.
b—broken. If one or both of the horizons separated by the boundary are discontinuous, so that boundary is interrupted.

Stages of Carbonate Morphology

Describe the stage of morphology (Fig. A1.5, Tables A1.5 and A1.6). In some places, there may not be stage II morphology in a sequence of nongravelly soils; rather, filaments of stage I become so common that the horizon meets the approximate percentage requirements for stage II. Holliday (1982) suggests that these latter occurrences be termed IIf to indicate their filamentous morphology.

I want to inject a word of caution on the recognition of carbonate morphological stages. In places, carbonate can be deposited on vertical faces by laterally seeping waters and thereby mask the pedogenic carbonate morphology (Lattman, 1973). In addition, M.N. Machette and R.E. Anderson (personal communication, 1991) have observed strong lateral (on contour) variations in carbonate morphology and accumulation along natural arroyos in arid parts of the eastern Great Basin. Hence, to study the morphology of pedogenic carbonate and avoid surficial cementation, one may have to dig back a meter or more.

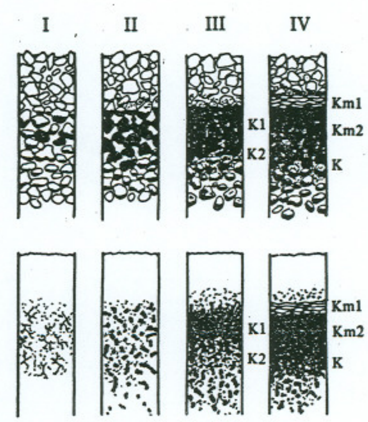


Figure A1.5 Sketch of carbonate buildup stages (I, II, III, IV) for gravelley (top) and nongravelley (bottom) parent materials. Machette (1985) added two more stages beyond stage IV (Table A1.5). In general, the stage morphologies merge to a common form at about stage III. *(Redrawn and modified from Gile and others, 1966, © 1966, The Williams & Wilkins Co., Baltimore.)*

Table A1.5 Stages of Carbonate Morphology

Stage	Gravelly Parent Material	Nongravelly Parent Material
I	Thin discontinuous clast coatings; some filaments; matrix can be calcareous next to stones; about 4% $CaCO_3$	Few filaments or coatings on sand grains; <10% $CaCO_3$
I+	Many or all clast coatings are thin and continuous	Filaments are common
II	Continuous clast coatings; local cementation of few to several clasts; matrix is loose and calcareous enough to give somewhat whitened appearance	Few to common nodules; matrix between nodules is slightly whitened by carbonate (15–50% by area), and the latter occurs in veinlets and as filaments; some matrix can be noncalcareous; about 10–15% $CaCO_3$ in whole sample, 15–75% in nodules
II+	Same as stage II, except carbonate in matrix is more pervasive	Common nodules; 50–90% of matrix is whitened; about 15% $CaCO_3$ in whole sample
Continuity of fabric high in carbonate		
III	Horizon has 50–90% K fabric with carbonate forming an essentially continuous medium; color mostly white; carbonate-rich layers more common in upper part; about 20–25% $CaCO_3$	Many nodules, and carbonate coats so many grains that over 90% of horizon is white; carbonate-rich layers more common in upper part; about 20% $CaCO_3$
III+	Most clasts have thick carbonate coats; matrix particles continuously coated with carbonate or pores plugged by carbonate; cementation more or less continuous; >40% $CaCO_3$	Most grains coated with carbonate; most pores plugged; >40% $CaCO_3$
Partly or entirely cemented		
IV	Upper part of K horizon is nearly pure cemented carbonate (75–90% $CaCO_3$) and has a weak platy structure due to the weakly expressed laminar depositional layers of carbonate; the rest of the horizon is plugged with carbonate (50–75% $CaCO_3$)	
V	Laminar layer and platy structure are strongly expressed; incipient brecciation and pisolith (thin, multiple layers of carbonate surrounding particles) formation	
VI	Brecciation and recementation, as well as pisoliths, are common	

Taken from Gile and others (1981) and Machette (1985), with further modification by R.R. Shroba (written communication, 1982).

Carbonate Effervescence

If dilute HCl (use a 1:10 ratio of concentrated HCl:water) is added to a soil containing $CaCO_3$, it will effervesce. The classes of effervescence are generally related to the amount of carbonate as well as to particle size (more rapid with smaller size) and mineralogy (slight with dolomite). Four classes are recognized:

Very slightly effervescent—few bubbles seen.
Slightly effervescent—bubbles readily seen.
Strongly effervescent—bubbles form low foam.
Violently effervescent—thick foam forms quickly.

For most geomorphic purposes, carbonate morphology stage is more useful than the classification of effervescence.

Salts and Silica Development

Pedogenic gypsum and silica have developmental stages that are similar to the stages of carbonate morphology (Table A1.7). One could devise a similar scheme for halite or any other accumulation of interest.

Cementation

Cementation refers to the brittle, hard consistence caused by some cementing agent, such as silica or $CaCO_3$, which, unlike clay, does not deform under pressure.

cw—weakly cemented. Mass is brittle and hard, but can be broken in hands.