

## **Appendix 2. Sedimentologic descriptions and outcrop observations for units underlying and overlying the Lava Creek B ash.**

This appendix presents descriptions of sediment underlying the Lava Creek B ash in the topographic amphitheater. Colors of sediment are based on visual comparison of dry samples to the Munsell Soil Color Charts (Munsell Color, 2009). Grain sizes follow the Udden-Wentworth scale for clastic sediments (Udden, 1914; Wentworth, 1922) and are based on field estimates. Sand textures are abbreviated as follows: very fine-lower, vfL; very fine-upper, vfU; fine-lower, fL; fine-upper, fU; medium-lower, mL; medium-upper, mU; coarse-lower, cL; coarse-upper, cU; very coarse-lower, vcL; very coarse-upper, vcU. Grain composition and percentages interpreted using a hand lens. Pebble sizes are subdivided as shown in Compton (1985). The term “clast(s)” refers to the grain size fraction greater than 2 mm in diameter. Clast percentages are estimated using percentage charts. Descriptions of bedding thickness follow Ingram (1954). Soil horizon designations and descriptive terms follow those of the Soil Survey Staff (1994) and Birkeland (1999). Stages of pedogenic calcium carbonate morphology follow those of Gile et al. (1966) and Birkeland (1999).

### **STRATA UNDERLYING THE LAVA CREEK B ASH**

#### **Unit 1A**

Sandy pebbles and cobbles deposited by the ancestral Rio Puerco: Bedding is very thin to thin and tabular to planar-cross-stratified (foresets are 0.6 m-thick). Gravel is rounded to subrounded, poorly sorted, and composed of: ~50% chert, 30% tan Mesozoic sandstone, 10% quartzite, 10-13% light gray, fine-grained intermediate volcanic rocks, 1-5% vesicular, dark gray basalt, 1% red granite. Sand is light yellowish brown (10YR 6/4), fU-vcU, subrounded (mostly) to rounded, and composed of quartz, ~5% feldspar, and 10-13% lithic grains. ~10% strong cementation. A few meters thick.

In the back of the narrow, grotto-like gully found in the center of Figure 6c, this unit is present beneath the Lava Creek B ash and underlying steeply dipping, gravelly colluvium of unit 3C. Here, unit 1A consists of intercalated sand and sandy pebbles-cobbles (mostly very fine to very coarse pebbles). Pebbly beds are medium (maximum thickness of 25 cm) to lenticular to U-shaped. Clasts are subrounded, moderately sorted, and similar in composition to that of unit 3C. The sand is well-bedded (horizontal-planar laminated to trough cross-laminated, with 14 cm-thick foresets). The sand is pale brown to very pale brown (10YR 6-7/3), very fine- to very coarse-grained, subrounded to rounded, poorly to well sorted within a bed, and composed of quartz, 5-7% feldspar, and 10-13% lithic grains. Clast imbrication and trough-cross-laminations indicate a 170 degree paleoflow direction.

#### **Unit 2C**

Steeply west-dipping beds (laminated to 10 cm-thick) of light gray (10YR 7/2), medium- to very coarse-grained sand and pebbly sand. Found along eastern side of Unit 2A and appears to have been on-lapped by Unit 2A. Sediment is interpreted to have been emplaced via gravitational-driven processes from erosion of Unit 1A.

### **Unit 2A**

Light yellowish brown (10YR 6/4), massive, clayey-silty very fine- to fine-grained sand. Consolidated. Interpreted to represent slow aggradation in a former arroyo. 4.5-5.0 m preserved but original aggradation was likely thicker and capped by gravelly Rio Puerco gravel.

### **Unit 3C**

Pebbly-cobbly colluvium shed from inferred Rio Puerco gravel that once capped Unit 2A. On the west (left) side of Figure 6b, the colluvium is mostly massive with some vague, thin beds dipping 20-25 degrees towards the northwest. Clasts likewise dip steeply to the northwest. A sharp, possibly erosional, contact separates Unit 3C from the overlying 3A alluvium there. The orientation of the steeply inclined beds suggest an arroyo margin that trended 35 degrees (NE); the arroyo likely drained to the northeast because the gravelly terrace deposit of Unit 2A lay to the east and the river was likely that direction as well.

On the east (right) side of Figure 6b, colluvial beds are very steeply inclined (40-50 degrees to the W) and the sediment consists of pebbles to cobbles. Maximum clast diameter of 30 cm. Clasts are mostly subrounded to rounded, poorly sorted, and composed of ~50% chert, 20% Mesozoic sandstone, 15-20% quartzite, 5-7% light gray, fine-grained, intermediate volcanic rock, 3-4% vesicular, dark gray basalt, and 1% red granite. The sand is light yellowish brown and very fine- to very coarse-grained (mostly coarse- to very coarse-grained).

### **Unit 3AC**

Very pale brown (10YR 7/3) mudstone that is massive and grades eastward into pebbly sand colluvium similar to that described for the western part of Unit 3C. Possible pebble-to cobble-size fall blocks. No channel-fills or sedimentary structures observed.

### **Unit 4AC**

Gully-fill preserved as a 50-70 cm-wide, 1.8 m-tall sliver alongside the modern cliff (Figures 5 and 6B). It is composed of light yellowish brown (10YR 6/4) pebbly sand. No obvious sedimentary fabric along outer parts but horizontal planar laminations are observed in the middle. Clasts consist of pebbles that are rounded to subrounded and poorly sorted. Cannot get a close enough view to determine clast composition. The sand is fL-vcU, subrounded, moderately sorted, and composed of quartz, 5-7% lithic grains, and 5-7% feldspar.

### **Unit 5C1**

Colluvium consisting of pebble- to cobble-size, hard, subangular blocks composed of pale brown (2.5Y 7/3) siltstone and very fine-grained sandstone of the Cerro Conejo Formation. The matrix between the fall blocks consists of pale brown (2.5Y 7/3), very fine- to medium-grained sand. Jumbled-up texture. Upper part has local beds (strings) of pebbles; these beds are 4-5 cm wide (thick) and horizontal to inclined. These seem to fill voids within the fall blocks. Fills an obvious paleo-gully that was 2.2 m deep and 2-4 m wide. The gully wall trended 080 degrees. Lowermost part of lower contact is obscured by Holocene sediment, but the middle and upper parts form a sharp buttress over Units 3AC (left) and 3C (right), as exhibited in Figures 6c and 6d. 1 m thick.

### **Unit 5A**

Alluvial sand and gravel. Well-stratified. Sand is planar-cross laminated and the gravel are in thin to medium, lenticular beds. The gravel consists of pebbles and minor cobbles. The sand is very pale brown to pale brown (10YR-2.5Y 7/4), fine- to very coarse-grained, subrounded, moderately to poorly sorted, and composed of quartz, 5-7% feldspar, and 10-12% lithic grains. Lower contact is sharp and underlain by Unit 4AC. Gully trends E-W. The sediment probably came from Unit 1A, 3C, or 4AC or from a more distant source. No good clast imbrication. 50-70 cm thick.

### **Unit 5C2**

Massive colluvium composed of fall blocks of cemented sandstone and siltstone-very fine-grained sandstone; these fall blocks are interpreted to have come from the Cerro Conejo Formation. The matrix between the fall blocks is composed of silt and very fine- to fine-grained sand. To the northeast is west-dipping, pebbly colluvium (Figure 6E). Surface 6S appears to have pebble armor on its surface. No soil beneath it.

### **Brown unit overlying the older erosional surface in the western topographic amphitheater**

Vaguely bedded. The beds are very thin to tabular. Sediment is yellowish brown (10YR 5/6) and composed of clayey-silty vL-cU sand. Lower contact is sharp. Thickness is variable, from 20 cm to >100 cm (see Figure 4). Upper 10 cm of the underlying Cerro Conejo Formation is a similar color, probably because of downward translocation of fines.

### **western butte paleovalley backfill**

About forty meters east of the western butte, this sediment consists of sandy pebbles in very thin to thin, tabular beds. Pebbles are very fine to very coarse, subrounded to rounded, and moderately sorted. Estimated clast composition: ~60% chert, 10-20% quartzite, 10% Mesozoic sandstone clasts, 5-7% light gray, fine-grained, intermediate volcanic rock, and 1-3% dark gray, vesicular basalt. Clast imbrication indicates a northeast to southeast(?) paleoflow direction. The sand is light yellowish brown (10YR-2.5Y 6/4), fU-vcU (mostly mU-vcU), subrounded, moderately sorted, and composed of quartz, 3% feldspar, and 10-12% lithic grains.

## **STRATA OVERLYING THE LAVA CREEK B ASH**

### **Unit 6A1**

See stratigraphic section descriptions (Appendix 1)

### **Unit 6A2**

This unit is interpreted to reflect deposition on the paleovalley margin, where alluvial fans interfinger with floodplain mudstones and sandstone. It coarsens from east to west. To the east, it is composed of very fine- to medium-grained sand interbedded with 30% clay-silt. The sand is pale brown (2.5Y 7/3) and in very thin to thin, tabular beds. The sand is well sorted within an individual bed and generally very fine- to medium-grained. The mudstone is pale brown to very pale brown (10YR 6-7/3) and in very thin to medium, tabular beds. 1% or less very thin to thin pebbly beds. Pedogenesis is obvious in the lower unit near the central stratigraphic section (see Appendix 1).

To the west, this unit includes sand and 10-15% pebbly beds. Pebbly beds are in very thin to thin, tabular beds. Minor medium, tabular beds of poorly sorted pebbly sand (very fine- to very coarse-grained) that fine upward. Gravel consists of very fine to very coarse pebbles that are rounded to subrounded and moderately sorted. Imbricated clasts give a 110-120 degree paleoflow direction. The sand is mostly pale brown (2.5Y 7/4), very fine- to fine-grained and locally silty or clayey. The sand is in very thin to thin, tabular beds that are internally horizontal planar-laminated to slightly wavy laminated. Total thickness of ~14 m.

### **Unit 6A3**

Sandy gravel interpreted to represent Rio Puerco channel facies. Very thin to medium bedding is exposed to north and is tabular, lenticular, or cross-stratified. 70-85% pebbles up to 6 cm across that are poorly sorted and composed of chert, quartzite, quartz sandstone, intermediate volcanics, sparse basalt, and sparse granite. Sands are fine- to very coarse-grained, poorly sorted, subangular to rounded, with colors from 7.5YR 7/3 to 10YR 7/3. Irregular (channelized) basal contact. 3 m thick.

### **Unit 6A4**

A fining-upward deposit interpreted to have been deposited on the Rio Puerco floodplain (from a sandy channel-fill up into clayey-silty fine-grained sand). The basal contact is abrupt (10 cm transition) and planar. The lower 1.6 m of Unit 6A4 consists of pale brown (10YR 6/3), fU-mU, well sorted sand composed of quartz, 5% feldspar, and 10% lithic grains. The upper 2.3 m of Unit 6A4 consists of very pale brown (10YR 7/3), clayey-silty, very fine- to fine-grained sand. 1% calcium carbonate nodules and trace gastropod shells.

### **Unit 6A5**

Similar to Unit 6A3 but more sand than gravel.

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