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Supplemental Data for "DeLong et al., Late Holocene alluvial history of the Cuyama River, California, USA"

Stratigraphic descriptions

The Cuyama River arroyo begins approximately 4.5 km downstream of the Hwy 133 bridge over the Cuyama River. The river gradually transforms from a wide braided channel to a narrower channel confined within vertical alluvial banks. There is no abrupt headcut at the start of the arroyo but only a zone of slightly higher channel slope (Figure 1).

E1

E1 provides the best stratigraphic evidence we found for the mid-Holocene history of the Cuyama River. The exposure is the farthest upstream that we examined in detail and consists of a thin (<1 m) layer of loose bedded to massive medium sand of D3 disconformably overlying a clearly older section consisting of bedded to massive silt, sandy silt and clay with several paleosols. Two radiocarbon ages indicate that the deposit capped by the second highest paleosol in the section was deposited in the mid-Holocene; a charcoal sample from a layer of charcoal in that paleosol gave an age of 4343 ± 46 ^{14}C yr BP (4890–5090 YBP), and a large fragment of detrital charcoal from within the sedimentary deposit just below the paleosols gave an age of 5332 ± 47 ^{14}C yr BP (6040–6320 YBP). Together with E7, located several kilometers farther downstream, this is the only section at which mid-Holocene age alluvium was observed along the Cuyama arroyo.

Along the entire upstream portion of the Cuyama arroyo, the main valley terrace is capped by a loose bedded to massive sand unit D3. This deposit is characterized by its coarse, sandy, loose texture, lack of soil development, minimal evidence for bioturbation, and its ~1 m thick tabular beds. This unit is often gravelly at its base, and tends to discomformably mantle buried soil horizons which may have been subaerially exposed at the time of deposition, or may have been a somewhat resistant layer below which fluvial erosion was limited. In other locations, this unit has a strong erosional base that cut into older sediments. The upper sandy unit tends to thicken downstream from < 1 m thick up to 4 m thick where it is exposed above deeper erosional unconformities.

E2

E2 provides age control for the upstream part of unit D3 where it caps the main valley terrace. It consists of 5 meters of D3 above a paleosol that appears to cap unit D1. Two radiocarbon ages of 176 ± 52 and 169 ± 30 ^{14}C yr BP (50–350 and 50–340 YBP, respectively) from detrital charcoal within a massive sand bed, and an OSL age of 175 ± 63 yr from stratigraphically between the two radiocarbon ages support our interpretation that this deposit (and therefore the main valley terrace in this area) is less than 350 years old. A radiocarbon age of 754 ± 30 ^{14}C yr BP (710–780 YBP)from a laterally extensive charcoal layer within the D1-capping paleosol indicates the upper and lower parts of this section are not conformable.

E3

E3 correlates well with E2 and displays the erosional nature of the basal D3 contact well. Here, D3 has a strongly erosional base and contains bedded sand and gravel that is deposited against basal and lateral erosional features. Two detrital pieces of charcoal yield ages of 157 ± 45 and 123 ± 36 ^{14}C yr BP (50–340 and 50–330 YBP, respectively), supporting our correlation with D3 at the previous exposure. An extensive charcoal layer within bedded sandy silts of unit D1 yielded an age of 812 ± 37 ^{14}C yr BP (730–840 YBP).

E4

At E4, we attempted to date a small exposure of "post-D3" deposits from an 2.6 m inset terrace with a gravely basal layer below weakly bedded to massive sand beds. Two radiocarbon ages from the sands are 127 ± 38 and 197 ± 37 ^{14}C yr BP (50–330 and 50–360 cal BP, respectively). These ages alone do not distinguish these deposits from D3 deposits that cap the much higher main valley terrace in this area, but the landscape position, and presence of D3 deposits higher in the landscape both upstream and downstream provide evidence that this is a younger deposit than D3.

E5

E5 indicates downstream thinning of D3 and exposes a thick, fairly homogenous exposure of E2. At E5, a 10 m thick section of horizontally bedded sand and silty sand is constrained by a single radiocarbon age of 379 ± 38 ^{14}C yr BP (370–560 YBP), taken from an extensive charcoal layer in a weak paleosol 6.3 m beneath the terrace tread. This age suggests that much of the exposure is D2. This exposure is capped by a 1.4 m thick bed of loose bedded sand that is correlative with the D3 deposits upstream that underlay the main valley terrace, but indicates considerable downstream thinning of this deposit. Beneath this upper deposit is a weak paleosol that caps D2.

E6

E6 marks the first location at which E3 deposits are inset into rather than capping the main valley terrace. Here, a distinct paleoerosion surface is present in section. Just above this surface is a charcoal layer that yielded an age of 136 ± 38 ^{14}C yr BP (50–320 cal BP). The fill above the erosional contact is inset within the main valley terrace in this area, suggesting that D3 is an inset rather than a terrace-capping deposit in this part of the valley. The erosional unconformity in the section becomes a subaerial fluvial scarp above the tread of the inset D3 fill. D3 deposits here are a sequence of coarsening upward beds of finely bedded silts and massive to bedded sands.

E7

The only other dated exposure of mid Holocene sediments that along the valley axis is at E7. Here, two sharp erosional surfaces are exposed in section. Beneath the lower unconformity, a large concentration of charcoal produced a radiocarbon age of 6772 ± 51 ^{14}C yr BP (7570–7740 YBP).

E8

E8 is a soil-capped 10 m sedimentary section with a significant erosional surface between D2 and D1. These features are also seen at several exposures farther downstream. Unlike upstream exposures, which are capped by the distinctive D3 lacking soil development, the terrace tread here is capped by a distinctive grey entisol. This soil shows little horizonation, but is easily identifiable by a 30–50 cm thick zone of organic accumulation that has a grey 10 YR 5/1 color when dry. This soil caps the main valley terrace for 10s of kilometers downstream of this point, in sharp contrast to the lack of soil development on top of D3 upstream. Chronological control for this section comes from a single radiocarbon age of 1301 ± 39 ^{14}C yr BP (1200–1350 YBP) from a charcoal layer on the erosional unconformity in section. This age is somewhat older than expected for the base of unit D2, but our interpretations of, and age control on, the stratigraphy at nearby exposures lead us to interpret this section as D2 over D1. However, it is possible that the D2/D1 contact is subtle here, and the age is from a D1/pre-D1 unit. An undated distinctive grey organic-rich deposit is exposed at the base of this exposure which may indicate a period of slow deposition and high water table previous to the erosional episode recorded by the overlying unconformity.

E9

E9 contains D2 over D1 with the distinctive D2-capping soil. We made considerable effort at exposure E9 to determine the ages of sedimentary deposits in order to constrain the record of fluvial processes exposed at this location. We were particularly interested in constraining the age of the terrace abandonment, the age of the primary unconformity in the section and the age of older deposits beneath the unconformity. Radiocarbon ages in the younger part of this section are in an age range that results in a wide range of possible calendar ages when calibrated. The comparison with OSL ages (see DeLong and Arnold, 2007 for further discussion) is largely consistent with the radiocarbon ages and allows for increased confidence in our age constraint. The upper unit at exposure E9 is clearly D2 underlying the main valley terrace with a distinctive capping entisol. Its local age is constrained by eight radiocarbon samples and three OSL samples. The range of calibrated radiocarbon ages and sample positions reveal an age of between 360 and 830 YBP for this unit, and the OSL ages indicate deposition could have occurred until as recently as 260 YBP. This suggests that along this reach the historical Cuyama arroyo may have existed for up to ca. 350 years.

Unit D1 lies beneath unit D2. Our age control indicates a period of local erosion between ca. 800 and 950 YBP based on a gap in depositional ages for the bracketing units. Ages from unit D1 range from 912 ± 39 ^{14}C yr BP to 2642 ± 38 ^{14}C yr BP (790 –2890 cal BP), but our least ambiguous age control comes from two laterally extensive charcoal layers of 1176 ± 39 and 1235 ± 40 ^{14}C yr BP (1030–1280 and 1120–1320 YBP, respectively) and four OSL ages ranging from 990 ± 80 yr to 1230 ± 90 YBP that span much of the lateral extent of D1 locally. An apparent unconformity at the downstream end of E9 cannot be interpreted unambiguously due to a fairly wide and overlapping range of ages on either side of the erosional feature. It may indicate a period of fluvial incision prior to sometime between 1250 and 2650 YBP or may simply be a slump in section.

E10

E10 provides support for our interpretation of E2 elsewhere and contains a typical steep, buttress-like erosional surface between inset D3 deposits and older deposits, as well as an isolated example of a preserved paleochannel. Three radiocarbon ages come from D2 deposits above a prominent unconformity in section. Two ages come from sediment that likely mantled the unconformity when it was subaerially exposed and developing what is now a paleosol on a thin colluvial mantle, and one comes from bedded silty fluvial material above the unconformity in section in the middle of D2. The two ages from the dipping paleosol are 351 ± 36 to 468 ± 36 ^{14}C yr BP (360–540 and 530–600 YBP , respectively), and the age from a layer of charcoal within bedded fluvial silts and sands above the unconformity is 371 ± 36 ^{14}C yr BP (370–550 YBP). These ages are consistent with those observed for D2 at exposure E9.

Just downstream, a swale in the terrace tread is mantled by a very thin layer of alluvium and organic material. The organic material (which was covered by 5 cm of fluvial or eolian sands) gave a "post-bomb" radiocarbon age indicating that this swale is a former channel, likely from when the local elevation of the modern Cuyama River was somewhat higher that it is today. This channel appears to be a failed meander cutoff, in map view it only extends 35 m across a narrow meander bend. Calibration of this age according to Hua and Barbetti (2004) indicates that this channel was likely active in either 1958–1961 CE or 1983–1986 CE. As such, this very thin deposit mantles what was most likely a transient channel location during fluvial incision or a particularly large flood, highlighting the ongoing recent incision along the Cuyama arroyo.

A few 10s of meters farther downstream, a distinct buttress unconformity separates D2 deposits from 4 m thick D3 deposits. As with D3 exposures further upstream, D3 deposits here are characterized by >1m thick beds of loose sandy material and a lack of soil development. Two radiocarbon ages provide chronological control on this deposit. Charred wood from the upper portion of this deposit yields a radiocarbon age of 207 ^{14}C yr BP (50–360 YBP). Charcoal from lower in the deposit has an age of 350 ± 37 ^{14}C yr BP (360–540 YBP) and is likely slightly older than the deposit from which it was taken due to residence time in the fluvial system. Based on the lack of soil, landscape position and correlation with similar deposits elsewhere, we interpret this deposit to be younger than 350 YBP.

E11

E11 is indicative of the subtlety of sedimentary exposures along the Cuyama arroyo and the necessity to use dating to interpret the age of exposure with subdued sedimentary features. It is 9 m thick and contains an extensive layer of charcoal 8 m from the terrace tread. This charcoal has a radiocarbon age of 1676 ± 34 ^{14}C yr BP (1570–1740 YBP) which is comparable to the ages near the bottom of the section at exposure E9. These are likely D1 or pre-D1 sediments. Two weak paleosols in this section appear to subtly truncate bedding farther upstream, lending to the possibility that there were two erosional episodes or depositional hiatuses. The upper paleosol is likely correlative with the paleosols that caps the major unconformity in section at E9 and E10, and is common in sections throughout the middle reaches of the Cuyama arroyo.

E12

At exposure E12, 12 m of bedded sand, silt and cobbles of unit D2 are exposed with no apparent unconformities or paleosols in section. Chronological control is provided by three radiocarbon ages and a single OSL age. The radiocarbon ages range from 544 ± 44 to 710 ± 68 ^{14}C yr BP (560–800 YBP) and the OSL age is 990 ± 80 YBP. As discussed in DeLong and Arnold (2007) we interpret the OSL age as spuriously old by perhaps 300 years. In general, this suite of ages and their stratigraphic positions more than 6 m below the terrace tread indicate that this is a single 12 m thick conformable exposure of D2.

Adjacent to the main terrace exposure at E12 is a low sandy terrace that we interpret to be the result of catastrophic flooding during the 1998 El Nino (Bowers, 2001). A single OSL age from this deposit of 35 ± 40 YBP is consistent with that interpretation. A single fragment of detrital wood sampled from this 1.5 m terrace yielded a radiocarbon age of 343 ± 98 ^{14}C yr BP

(360–550 YBP), which we interpret to be older then the deposit from which it was sampled. This obviously detrital age highlights the problems of detrital and reworked carbon in the Cuyama River Valley.

E13

At E13, a 6.5 m thick exposure of the main valley terrace is capped by a entisol that appears to be the same as the soil that caps D2 elsewhere along this reach of the arroyo. This interpretation is complicated by a single radiocarbon age of 826 ± 39 ^{14}C yr BP (730–950 YBP) from an extensive layer of charcoal just 0.5 m beneath the terrace tread which indicates an age more compatible with D1. There are several possibilities for this somewhat unexpectedly old age. The simplest explanation is that the charcoal is significantly older than the sediment with which it was deposited, likely due to limited transport distance of burned old wood. Another possibility is that locally D1 underlay the terrace tread, but there is no other evidence to support a locally old age of the geomorphic surface at this location.

Just downstream, a 5 m terrace lacking noticeable soil development yielded an age of 145 ± 30 ^{14}C yr BP (50–330 YBP) from charcoal in bedded sands 1 m below the terrace tread. This age supports the interpretation that this thickly bedded, loose sandy deposit is D3, and likely correlative with (i) the other 3–6 m thick loose sandy inset fill terraces that are common along the middle reaches of the Cuyama arroyo, and (ii) the loose sandy upper unit underlying the main valley terrace in the upper 7.5 km of the Cuyama arroyo.

E14

A 7 m exposure of the main valley terrace is capped by the distinctive entisol at E14. This is supported by a radiocarbon age of 532 ± 38 ^{14}C yr BP (560–690 YBP) from 1.1 m below the terrace tread. At 2.6 m below the terrace tread a radiocarbon age of 1320 ± 44 ^{14}C yr BP (1200–1360 cal BP) from a locally extensive charcoal layer indicates that there may be D1 deposits at this location as well. This interpretation is supported by presence of a weak silty paleosol 1.6 m from the terrace tread.

0.5 km downstream from exposure E14, a similar 6 m exposure yielded an age of 641 ± 34 ^{14}C yr BP (600–720 YBP) from 1.5 meters below the tread of the main valley terrace. This section is capped by the distinctive D2 entisol, confirming an exposure of unit D2, at least in the upper portion of the exposure.

E15

E15 reveals a sequence of interbedded axial and tributary D2-equivalent deposits in a tributary gully cut into an alluvial terrace sloping toward the valley axis. Four relatively young radiocarbon ages (all ≤461 ^{14}C yr BP) indicate that this deposit is no older than the D2 deposit along the valley axis exposures. These ages also suggest that sediment was being supplied from Caliente Range hillslopes during D2 alluviation. Other exposures of coarse subangular gravel, cobbles and boulders interbedded with axial silts, sands, and gravels on the north edge of the axial valley where it sits close to the Caliente range-front support this interpretation.

The chronology for this deposit is complicated by a radiocarbon age of 107 ± 30 ^{14}C yr BP (50–320 BP) from a split of a sample that also yielded an age of 336 ± 36 ^{14}C yr BP (360–530 YBP). The split sample is from a layer of charcoal 2.7 m from the tread of this tributary terrace, so the age may be from a mix of different aged wood within a single charcoal layer. Importantly, the presence of the distinctive soil at this location contradicts the validity of such a young piece of charcoal. This raises the possibility of sample contamination of one of the splits during dating.

E16

E16 reveals that D3 caps the main valley terrace along a second reach of the Cuyama arroyo, as it does in the upstream-most reach. It is a 9m thick exposure of axial alluvium. It is characterized by 3.8 m of bedded to massive sands and cobbly gravel with a sharp and locally slightly erosional basal contact at the top of the section. Below this is a distinctive 1.2 m thick brown silty interval, which, in turn, overlays a 0.5 m thick sandy gravel unit that may be a paleochannel deposit. Below this are more bedded sands and silts with minor gravel. chronological control comes from 11 radiocarbon ages. The ages from this section reveal some ambiguities and stratigraphic reversals, but, in general, support the interpretation that this exposure contains D3 deposits overlying unit D2. The upper coarse massive to weakly bedded loose sands and gravels with no obvious soil development yielded two radiocarbon ages of 121 ± 30 and 110 ± 36 ^{14}C yr BP (50–320 YBP), and another age of 469 ± 34 ^{14}C yr BP (530–630 YBP). We attribute the older age to detrital charcoal and use the sedimentology and younger ages to support our interpretation that this unit represents deposit D3. Beneath the erosional contact at 3.8 m depth, 8 radiocarbon samples yielded ages from 359 ± 38 to 2590 ± 180 ^{14}C yr BP (370–3210 YBP). The youngest age is from just beneath the contact and is from a prominent layer of charcoal so should provide a useful minimum age. The lowest part of the section yields three ages between 537 ± 35 and 736 ± 42 ^{14}C yr BP (560–790 YBP). These ages support the interpretation that the entire deposit beneath unit D3 is unit D2 in this area.

This is similar to the exposures (E1–E7) in the upstream 7.5 km of the Cuyama arroyo in that the very young D3 deposits cap the main valley terrace, rather than sit as an inset terrace, as is the case in the middle reaches of the Cuyama arroyo.

E17

E17 confirms that E3 is located in the upper portion of the main valley terrace along this reach, stratigraphically above D2 rather than as an inset fill. The 8.7 m terrace exposure is constrained by five radiocarbon ages. As observed elsewhere, at least one age (1361 ± 32 ^{14}C yr BP (1240–1390 YBP)) appears to be too old. The cause of this is likely reworking of older charcoal or burning of old wood on hillslopes. All other ages are suggestive of a very young depositional sequence, similar to the section at E16. A difference, however, is that there is no obvious contact between D3 and D2 deposits in this section, and we can only infer that D2 was deposited here at 584 ± 69 ^{14}C yr BP (560–720 YBP) from the radiocarbon sample taken 7.2 m below the terrace tread. The presence of D3 in the upper part of this section is confirmed by an age of 203 ± 30 ^{14}C yr BP (50–350 YBP) from 0.5 m below the tread, and 198 ± 38 ^{14}C yr BP (50–360 YBP) from 3.0 m below the terrace tread. An age of 340 ± 39 ^{14}C yr BP (360–540 YBP) from 3.3 m beneath the terrace tread may constrain the location of the D2–D3 contact but no obvious stratigraphic disconformities support this interpretation.

A single radiocarbon age of 695 ± 34 ^{14}C yr BP (610–740 YBP) from tributary channel facies exposed along a tributary gully 350m from the valley axis near E17 suggests that the tributary was supplying sediment to the valley axis at the same time as D2 was being deposited along the valley axis.

At nearby exposures with no age control, the presence of both D2 and D3 is more obvious. 500 m upstream from E17 the arroyo wall exposes 4 m of loose sandy gravel over more indurated and finely bedded sands and silts. The contact between these two units is sloping and clearly erosional and disconformable in nature.

Approximately 600 m downstream, an 8 m thick exposure of axial alluvium consists of 0.6 m of loose bedded sand over a sequence of what appear to be coarse sandy flood deposits containing occasional gravel clasts. A single large piece of detrital charcoal 4.2 m beneath the terrace tread yielded an age of 1407 ± 40 ^{14}C yr BP (1330–1430 YBP). We interpret the upper 0.6 m of this section to be deposit D3. Whether the radiocarbon age from the middle of this section is indicative of the age of the deposit from which it was taken, or has a detrital age is unclear. It may be that the lower part of this section is D2, but the older age suggests it may be a locally preserved older deposit.

E18

E18 reveals that in the lowermost arroyo reach deposit E3 again sits as a inset fill terrace inset into D2 deposits. Here, the main valley terrace, at only 5.5 m high, is considerably lower than elsewhere in the valley. This exposure consists of two terrace levels at slightly different elevations and an unconformity in section that correlates with the subaerial scarp separating the two terrace levels. Age control comes from two radiocarbon samples, though we interpret at least one of the ages as being unreasonably old. The younger deposit beneath the lower alluvial surface and above a distinct erosional unconformity yields a radiocarbon age of 386 ± 32 ^{14}C yr BP (370–560 YBP) from a piece of detrital charcoal taken 15 cm below the terrace tread. This unit is characterized by 2.5 m of loose, bedded to cross-bedded sands with no apparent soil development. Despite its incompatible readicarbon age, this appears to be unit D3 based on its distinctive sedimentology. Beneath the main valley terrace here, a section of bedded clayey, silty, sandy to cobbly alluvium is capped by a distinctive dark grey entisol. This deposit yielded a radiocarbon age of 823 ± 34 ^{14}C yr BP (730–840 YBP) from a fragment of detrital charcoal taken from 2.8 m below the higher terrace tread. This age may also be somewhat older than the deposit from which it was sampled. Based on landscape position, sedimentology, and the distinctive weak soil formation, we interpret this deposit to be D2.

Just upstream, a 2 m inset terrace yielded a radiocarbon age of 716 ± 45 ^{14}C yr BP (610–780 YBP), which is clearly a detrital age given the obvious youth of this loose massive sand deposit. The deposit is inset into all other terraces in the area and appears indistinguishable from the deposit we interpret as the 1998 El Niño flood deposit at E12.

Alluvium in bedrock canyon downstream of arroyo reach: E19 and E20

Just downstream of exposure E18, the Cuyama Valley narrows and is characterized by a bedrock stream channel with little floodplain or valley sediment storage. In a few locations, there are narrow alluvial deposits along the valley margin. At E19, a 4 m high exposure contains a bouldery fluvial deposit sitting beneath gravelly sand which in turn sits beneath a 1.5 m thick sandy deposit that contains historical material including a tire. A radiocarbon age from charcoal sampled from bedded sands just down-section from the modern deposit yielded a radiocarbon age of 102 ± 30 ^{14}C yr BP.

At E20, a 6.5 m exposure consists of bedded clays, silt, sand and gravel sitting above a coarse bouldery deposit. The finer deposits are fairly similar in character to D2 deposits in the wider alluvial valley reach. A radiocarbon age of 378 ± 30 ^{14}C yr BP comes from charcoal sampled 2.9 m beneath the terrace tread.

Caliente Range tributary exposures

In order to understand the relationship between axial alluvial episodes and sediment delivery from the adjacent Caliente Range, we dated alluvial material stored in the principal canyons of the south flank of the Caliente Range. Unfortunately, the radiocarbon ages do not allow for clear interpretation of the Holocene history of the tributary canyons. The ages have a very wide range, and poorly exposed, highly variable stratigraphy precludes clear correlation between sections. The Caliente Range currently has extremely low vegetation density and it is possible that the wide range of radiocarbon ages is due in part to long-term storage of woody material on hillslopes and infrequent wildfires that released a wide age range of charcoal to the channels in discreet events.

In Padrones Canyon at exposure TE1 ('tributary exposure' 1), 850 m upstream of the Caliente Range front, sand-dominated bedded material is exposed in a 3.5 m terrace cut. Detrital charcoal sampled 2.0 m beneath the terrace tread yielded an age of 2019 ± 33 ^{14}C yr BP (1890–2100 YBP), 30 m upstream a fragment of wood from a similar stratigraphic location yielded an age of 1689 ± 37 ^{14}C yr BP (1580–1750 YBP). These non-overlapping ages suggest that alluvium stored in this canyon is older than the majority of alluvium stored in the terraces along the main Cuyama River valley.

Exposure TE2 is a 2 m arroyo cut into the head of a Caliente Range alluvial fan. One radiocarbon sample from poorly sorted silts, sands and gravels yielded an age of 1703 ± 39 ^{14}C yr BP (1580–1750 YBP). The age of this alluvium is in general agreement with the age of alluvium at TE1.

Further west, Morales Canyon contains abundant stored alluvium exposed along a continuous 8 km long arroyo. Unfortunately, the wide scatter in ages and the highly variable stratigraphy preclude a precise reconstruction of Holocene fluvial history.

Near the canyon mouth at TE3, a 6 m exposure of bedded sands, silts and gravels 4.5 m beneath the terrace tread yielded ages of 4343 ± 41 ^{14}C yr BP (4890–5090 YBP) and 927 ± 39 ^{14}C yr BP (790–980 YBP) at 4.0 m below the terrace tread 200 m upstream.

At TE4, a 4.5 m terrace exposure yielded two ages of 2911 ± 74 ^{14}C yr BP (3000–3260 YBP) from 2.4 meters below the terrace tread and 3248 ± 41 ^{14}C yr BP (3430–3620 YBP) from 2.3 meters beneath the terrace tread and 300 m upstream. These sediments are primarily weakly bedded to chaotic silty/clayey gravel that appear to be dominated by flood and debris flow deposits, but are difficult to trace laterally as coherent depositional units.

Further upstream at TE5, a large (5 cm) piece of charcoal from bedded sands 4.1 m from the top of a 6.1 m terrace exposure yielded an age of 1927 ± 64 ^{14}C yr BP (1860–2030 YBP).

At TE6, a 4.4 m exposure of bedded to massive and chaotic silts, sands and gravels yielded ages of 1297 ± 31 and 1156 ± 31 ^{14}C yr BP (1230–1340 and 1030–1220 YBP, respectively) from 2.7 and 2.3 m below the terrace tread, respectively.

Farther upstream, at TE7, charcoal taken from bedded silts and sands 4 m beneath the tread of a 6 m terrace yielded an age of 3680 ± 42 ^{14}C yr BP (3950–4200 YBP), and just upstream, past a small tributary junction, a 3 m exposure of bedded sands and imbricated gravels yielded an age of 185 ± 30 ^{14}C yr BP (50–350 cal BP). This sample, while strikingly younger than all other ages from Morales Canyon was taken from a concentration of charcoal dispersed through a bedded layer of sand and gravel, so is unlikely to have been introduced through bioturbation. More likely, it represents local preservation of very young alluvium.

REFERENCES

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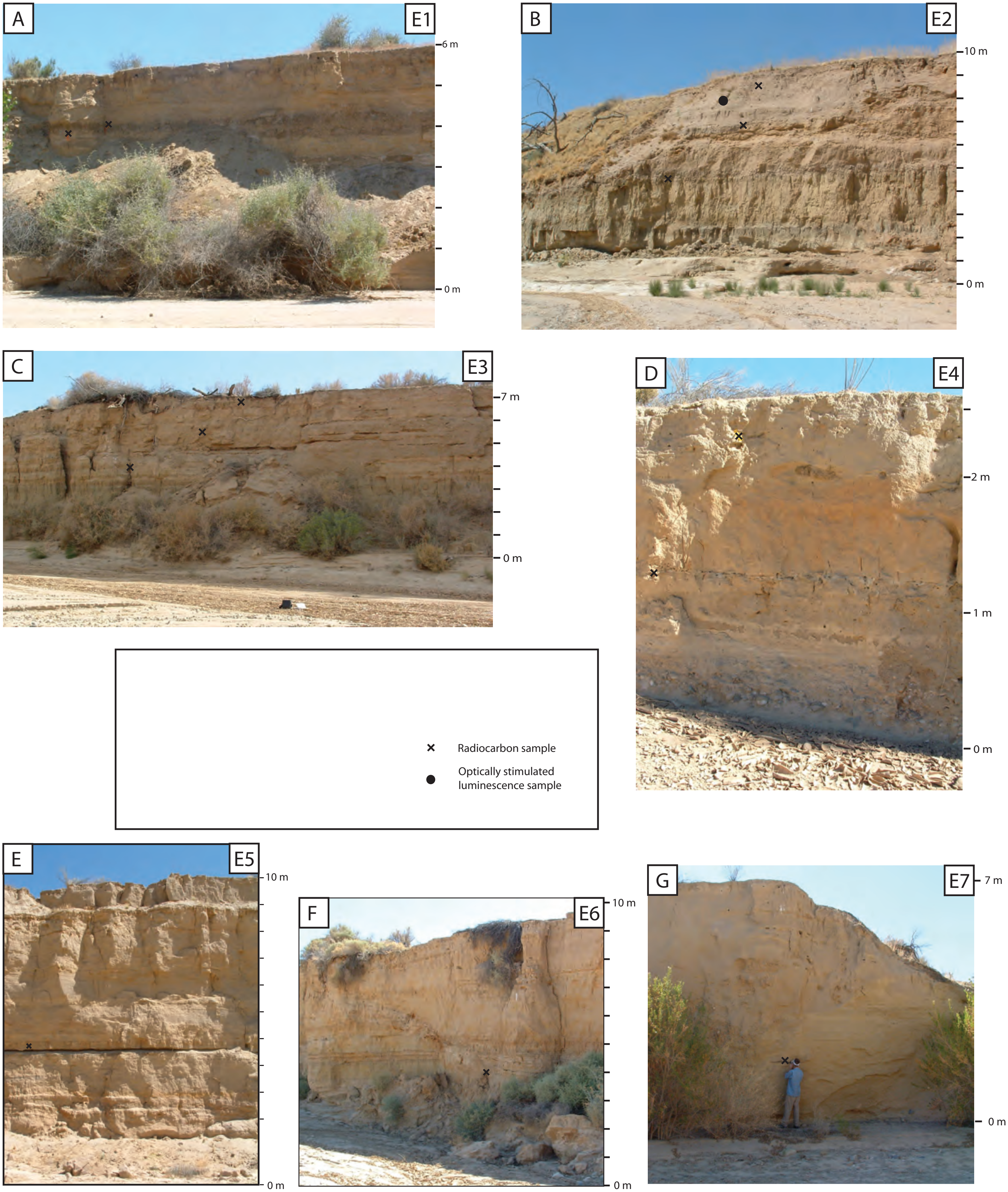
Hua, Q., and Barbetti, M., 2004, Review of Tropospheric Bomb ^{14}C Data for Carbon Cycle Modeling and Age Calibration Purposes: Radiocarbon, v. 46, p. 1273–1298



A
E1
6 m
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B
E2
10 m
0 m
C
E3
7 m
0 m
D
E4
2 m
1 m
0 m
Radiocarbon sample
Optically stimulated luminescence sample
E
E5
10 m
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F
E6
10 m
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G
E7
7 m
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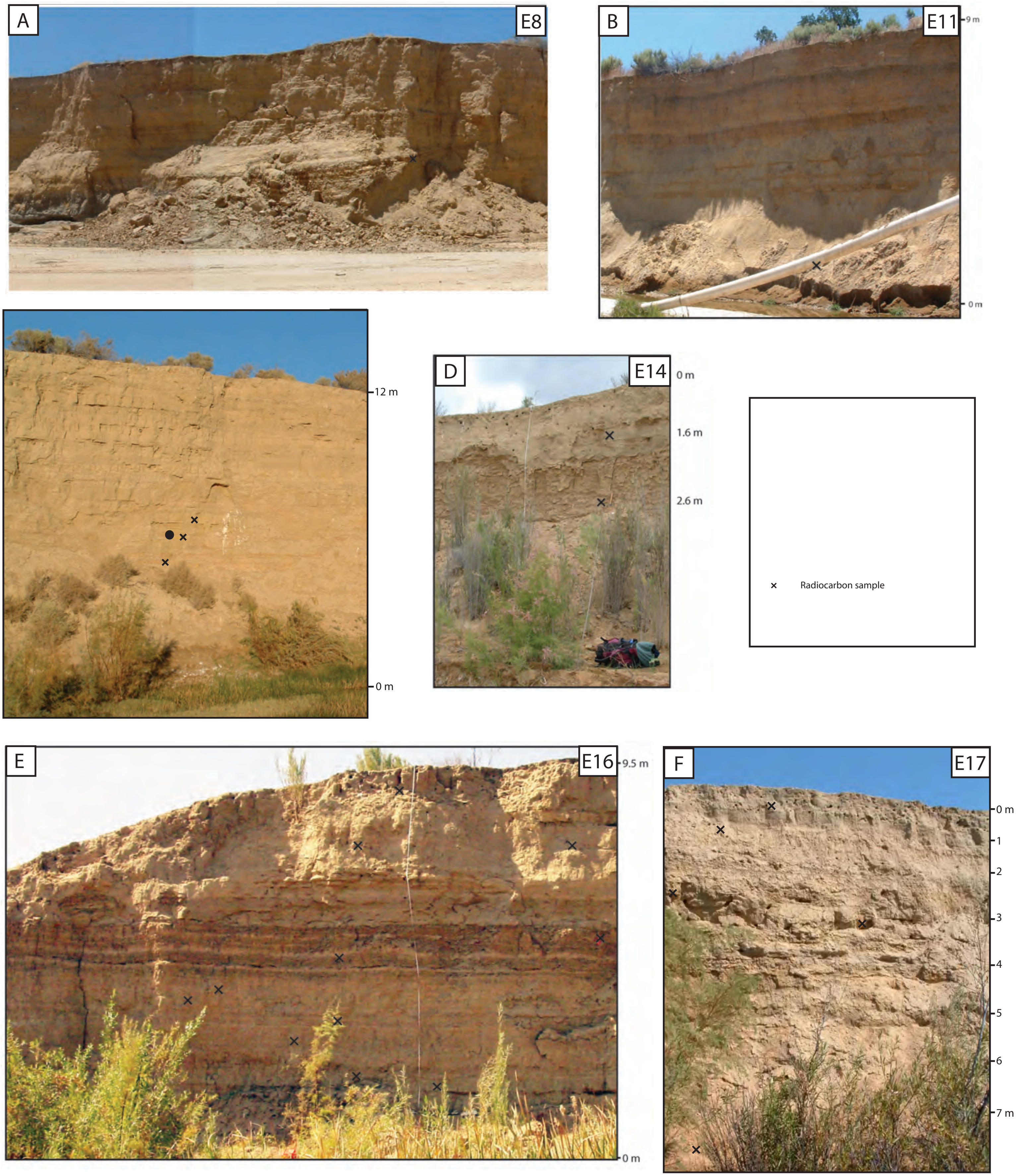
A
E8
B
E11
9 m
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12 m
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D
E14
0 m
1.6 m
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× Radiocarbon sample
E
E16
9.5 m
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