Paleoliquefaction Study of the Willamette River Valley, Portland to Corvallis, Oregon: Follow-up Investigations 2004

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John D. Sims
John Sims & Associates
3439 Bakerton Road
Harpers Ferry, WV 25425

Tel: 304-876-8525
Email: jds127@adelphia.net

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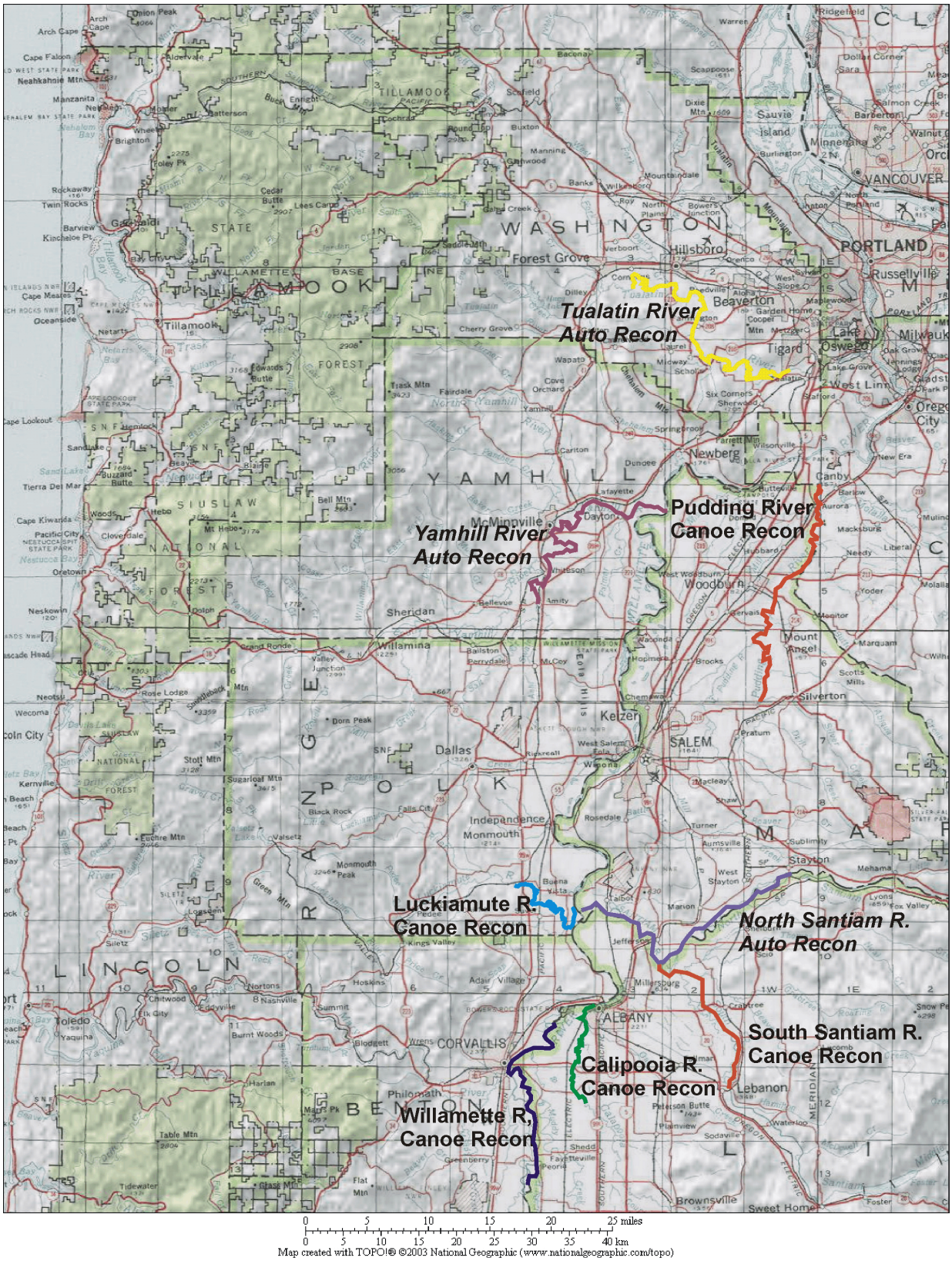
Introduction

Prior work in Oregon along the Columbia and Willamette rivers identified paleoliquefaction structures (Atwater, 1994; Obermeier and Dickinson, 1997; Maden, written comm., 1999, and Thurber and Obermeier, 1996, unpub. manuscript). Obermeier and Dickenson (1997) found paleoliquefaction structures between 35 and 90 km from the mouth of the Columbia. The structures they found are all related to the great 1700 A.D. earthquake documented on the Washington and Oregon coast by Atwater (1987, 1995). Many deposits exposed along the Columbia are historical, based on navigation charts that show the riverbanks changing by tens of meters in decades, either due to erosion or deposition (Maden, written communication, 1999). Prior work in the Willamette River system is of reconnaissance nature only and most of the data remains unpublished (Thurber and Obermeier, 1996, unpub. manuscript).

In August 2002 Martitia Tuttle and I conducted canoe surveys for paleoliquefaction features along parts of the Calapooia, Luckiamute, and Willamette Rivers. I conducted conducted canoe surveys along South Fork of Santiam Rivers, and additional parts of the Willamette (Fig. 1). I conducted auto and foot reconnaissance in the lower 40 km of the North Fork Santiam River and the South Yamhill River from near Amity to its mouth. The canoe surveys were conducted using standard procedures developed Tuttle and Sims. We examined cutbanks for paleoliquefaction features, primarily sand dike intrusions. Stratigraphic and sedimentologic contexts are first established and samples of organic material for radiocarbon analysis collected as available. The location of relevant features were measured with a global positioning system and marked on topographic base maps. Liquefaction features are described in terms of their size (width of dikes, and lateral extent and thickness of sand blows and sills), orientation, sedimentary structures, crosscutting relations, soil development, and stratigraphic context.

We conducted detailed investigations in August 2004 when the water level was low and cut banks best exposed to explore for additional sites to extend the areal study of paleoliquefaction features. at four sites along the Calapooia River selected for additional study following radiocarbon dating analysis. The detailed investigations were to better establish the radiocarbon age dates and liquefaction feature relationships. We collected new age dating samples from the Calapooia sites for both radiocarbon and Optically Stimulated Luminescence (OSL) at sites having sand dikes but no radiocarbon datable material. I [JDS] also conducted an auto and foot reconnaissance of 54 km of the Pudding River and a canoe survey with Martitia Tuttle of 22 km the Pudding River from near Whiskey Hill to Canby to extend the range of paleoliquefaction structures in the Willamette Valley. We also conducted a land reconnaissance of about 70 km of the Tualatin River to.


Tualatin River
Auto Recon
Pudding River
Canoe Recon
Yamhill River
Auto Recon
Luckiamute R.
Canoe Recon
North Santiam R.
Auto Recon
South Santiam R.
Canoe Recon
Calipooia R.
Canoe Recon
Willamette R.
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WASHINGTON
PORTLAND
VANCOUVER
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Beaverton
Tigard
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Dayton
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Dallas
Independence
Monmouth
Stayton
ALBANY
CORVALLIS
Lebanon
Brownsville
Sweet Home
Tillamoor
Tillamook
Oceanside
Cannon Beach
Toledo
Newport
Lincoln City
Yamhill
Sheridan
Willamina
Forest Grove
Cornelius
Sherwood
Tualatin
Wilsonville
Canby
Molalla
Mulino
Scappoose
Sauvie Island
Milwaukie
Oregon City
West Linn
Lake Oswego
Gervais
Jefferson
Scio
Lyons
Mehama
Marion
Aumsville
Turner
Rosedale
Falls City
Dallas
Kings Valley
Philomath
Monroe
Junction City
Harrisburg
Lebanon
Sodaville
Waterloo
Shedd
Peoria
Fayetteville
Greenberg
Millersburg
Albany
Brownsville
Sweet Home
Foster
Tidewater
Toledo
Yaquina
Siletz
Logsden
Neskowin
Pacific City
Cloverdale
Oretown
Tillamook
Netarts
Rockaway
Twin Rocks
Cannon Beach
Arch Cape
Cape Falcon
Neahkahnie Mtn
Manzanita
Nehalem
Wheeler
Brighton
Cape Meares
Cape Lookout
Tierra Del Mar
Pacific City
Cape Kiwanda
Neskowin
Lincoln City
Newport
Yachats
Waldport
Florence
Reedsport
Coos Bay
Bandon
Gold Beach
Brookings
Port Orford
Coquille
Myrtle Point
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Reedsport
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Coos Bay
Bandon
Gold Beach
Brookings
Port Orford
Coquille
Myrtle Point

Calapooia River Sites

We conducted detailed site investigations at 4 sites on the Calapooia River formerly surveyed in the 2002 field season. These sites were selected after the results from radiometric dating of paleoliquefaction features discovered in the 2002 fieldwork and analysis that were deemed critical to the understanding of the pattern, frequency and age of liquefaction events in the Willamette Valley. These sites are designated CR-7 (UTM 10T-488076, 4934306), CR-8 (UTM 10T-488543, 4935371), CR-10 (UTM 10T-488499, 4936574), and CR-14 (UTM 10T-490020, 4929161).

In 2002 we surveyed the lower 32 km of the Calapooia River from the confluence of Butte Creek to the mouth at Albany (Figure 2). Above its confluence with Butte Creek becomes too shallow for canoe, and its banks are low and heavily vegetated. In general the stratigraphic section in the lower Calapooia is well exposed. Four paleoliquefaction sites were found on the Calapooia River confirming the unpublished work of Thurber and Obermeier. All the features found are sand dikes from 1 to 12 cm wide. A sand dike accompanied by a sand blow buried in fluvial sediment occurs at site CR-8. Weathering characteristics of the host and the dike suggest that the features are a few hundred to a few thousand of years old. We also measured several sections that have datable material that will allow us to place the liquefaction features in context (Table 1). Direct age dating of liquefaction structures is sparse but the most accurate radiocarbon ages are between 2900-3100 yr Cal. BP. No young features attributable to the A.D. 1700 Cascadia subduction zone event were found. We also discovered Native American occupation sites at two sites[1], which contained ancient fire-pits with abundant charcoal. These archaeological sites were not associated with paleoliquefaction features but can provide additional dating context to the deposits enclosing them.

The oldest radiocarbon date from the Calapooia drainage is 3090-2900 yr Cal. B.P. Young age dates that we had from material collected in 2002 and 2004 ranged from 560-900 yr Cal. B.P. These dates were, on subsequent reexamination, determined to be from inset terraces that provide minimum age constraint did not reflect the age of liquefaction. Two generations of dikes at site CR-10 have a minimum age of 3090-2900 yr Cal. BP. There are at least two generations of dikes present in the Calapooia drainage. From our radiocarbon dates dating, there is one event that pre-dates 2900 yr Cal. B.P. and one or two events post-date 900 yr B.P. One would hope for a previously dated marker to place a maximum age constraint on the older features. This far we have not identified one. However, we have abundant charcoal samples from various stratigraphic sections in the Calapooia drainage that might provide this clue. We do know that the features formed in late Holocene after the Glacial Lake Missoula floods but before 2900 yr B.P. Further radiocarbon dating may help to differentiate additional generations. We collected 31 radiocarbon samples from the Calapooia drainage but dating in the section studied in 2002 and 2004 was limited six because of budget constraints

In August 2004, at low water level, I revisited four sites along the Calapooia that might allow a better determination of age dates and liquefaction feature relationships (CR-7, CR-8, CR-10, and CR-13/14). The first three sites were in similar condition as they were at the 2002 examination whereas the last had been greatly altered by erosion and perhaps human activity.

[1] We do not present the locations of Native American sites in order to protect them.

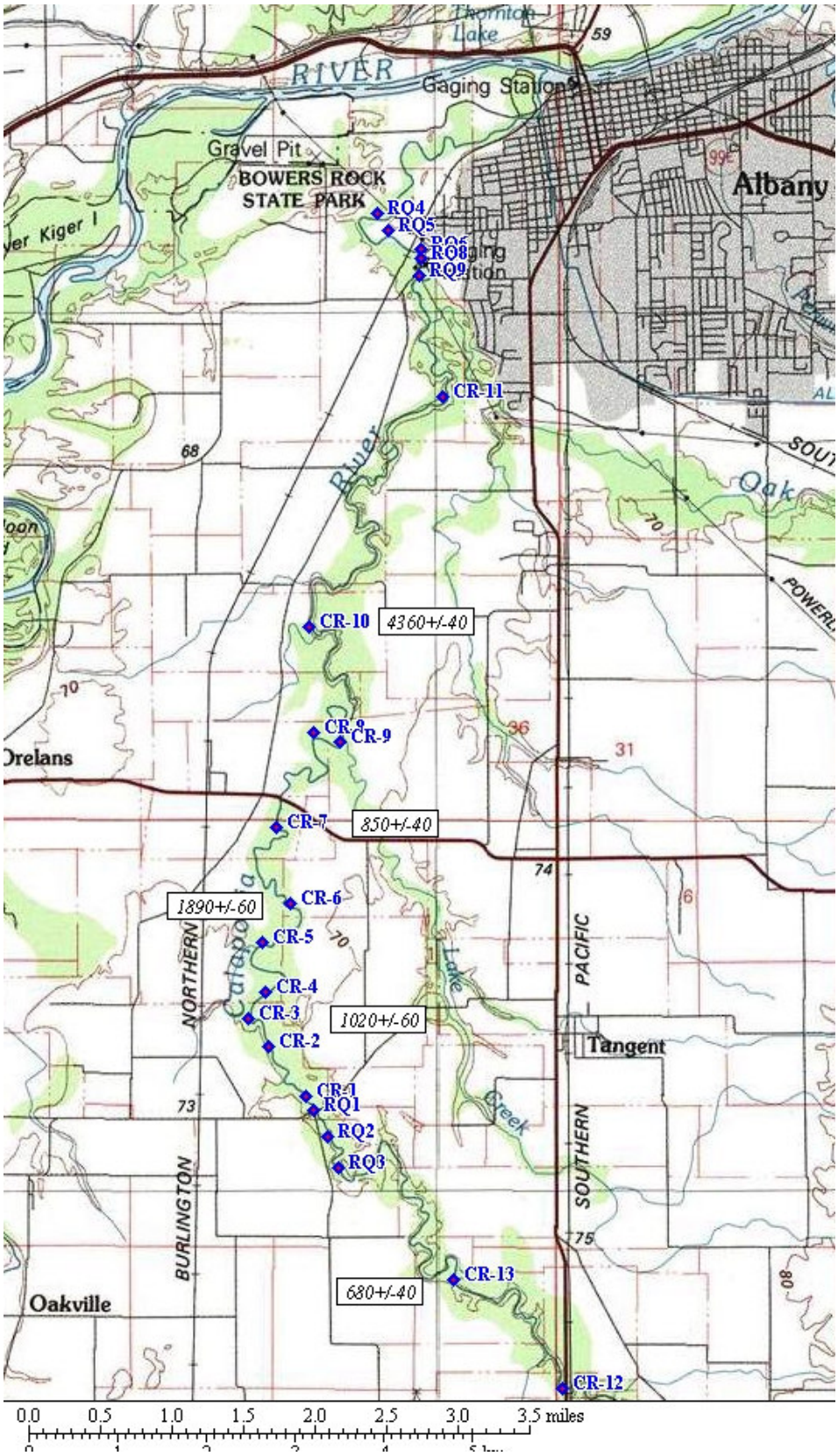
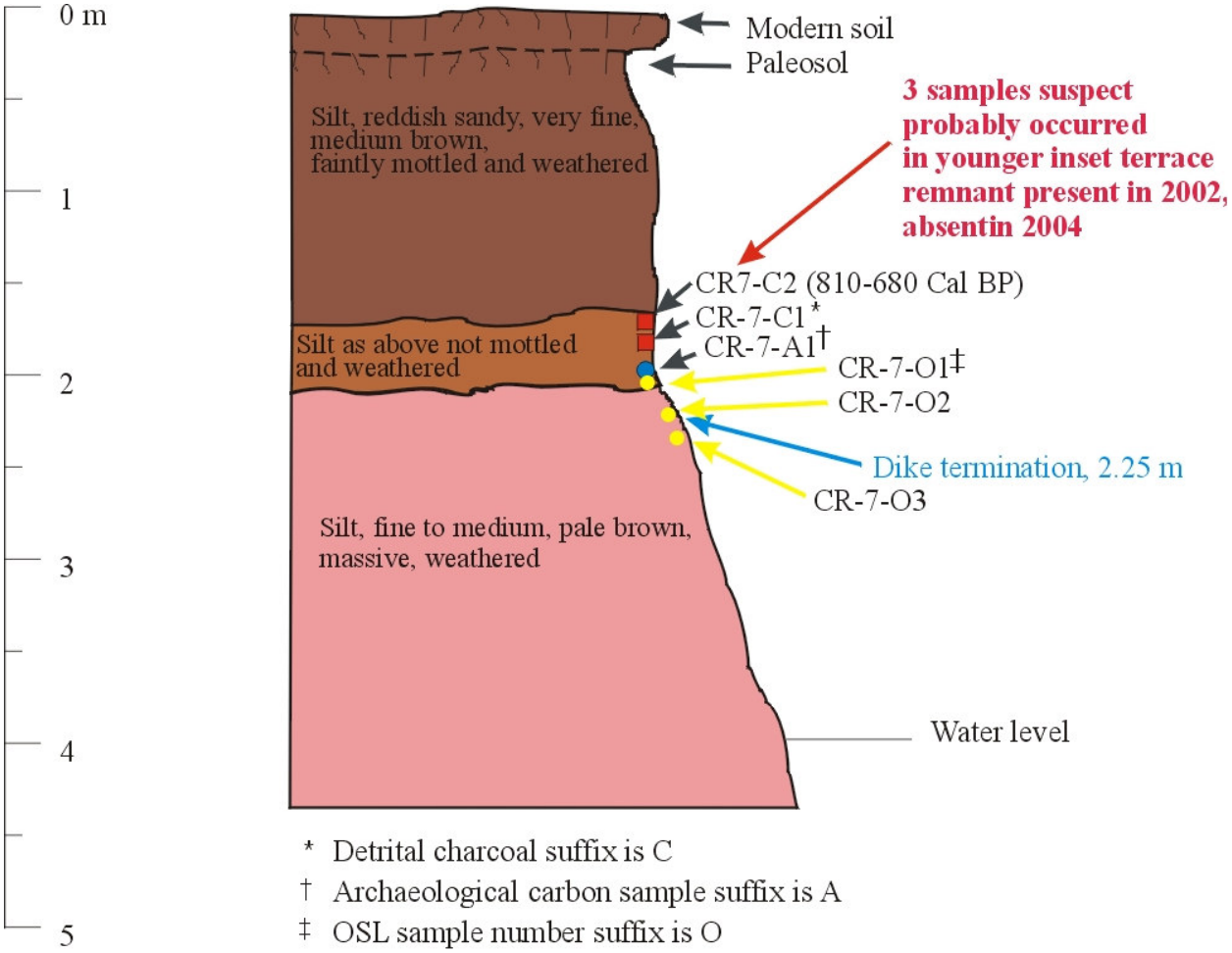


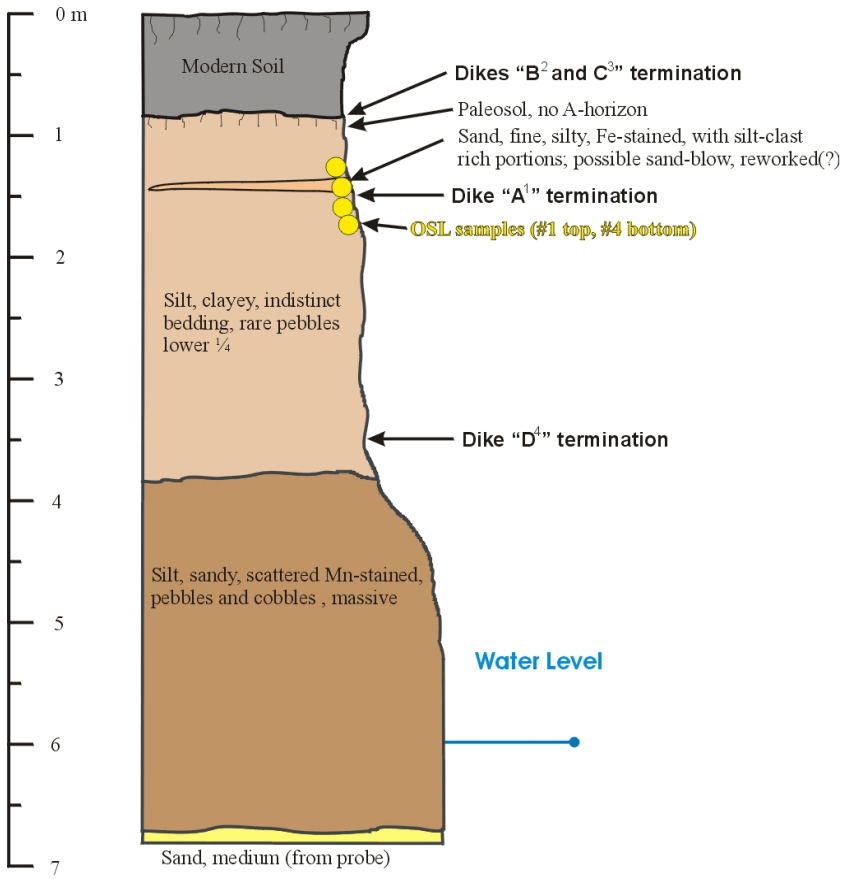
Figure 2. Map of paleoliquefaction study sites along the Calapooia River.

Site CR-7: The reexamination of site CR-7, which was better, exposed than in 2002 revealed that the material collected and dated from the site represented a remnant of a younger inset terrace that postdates the host and the sand dike (Figure 3). No additional datable material was found at the site. Because of the importance of the site we took three samples for OSL dating. The sand dike at this site appears similar in pattern and weathering to the two new dikes discovered at CR-10 during the 2004 revisit.



Calipooia River Site CR-7

Reexamination of site CR-8 revealed that it was in the same condition as the 2002 visit and was extremely well exposed. We found an additional dike on this visit bringing the total number of dikes to five (Figure 4). Because the site has so many well-exposed dikes we searched again for radiocarbon samples and found none. Examination of the soil profile by Tuttle suggests that the host and the dikes are relatively old (5-10 ka?). Because of the importance of the site we took three samples for OSL dating. OSL dating is pending.



[1] Dike A consists of: Sand, silty, fine to medium grained, some Fe-stain; extends ~4mm into soil

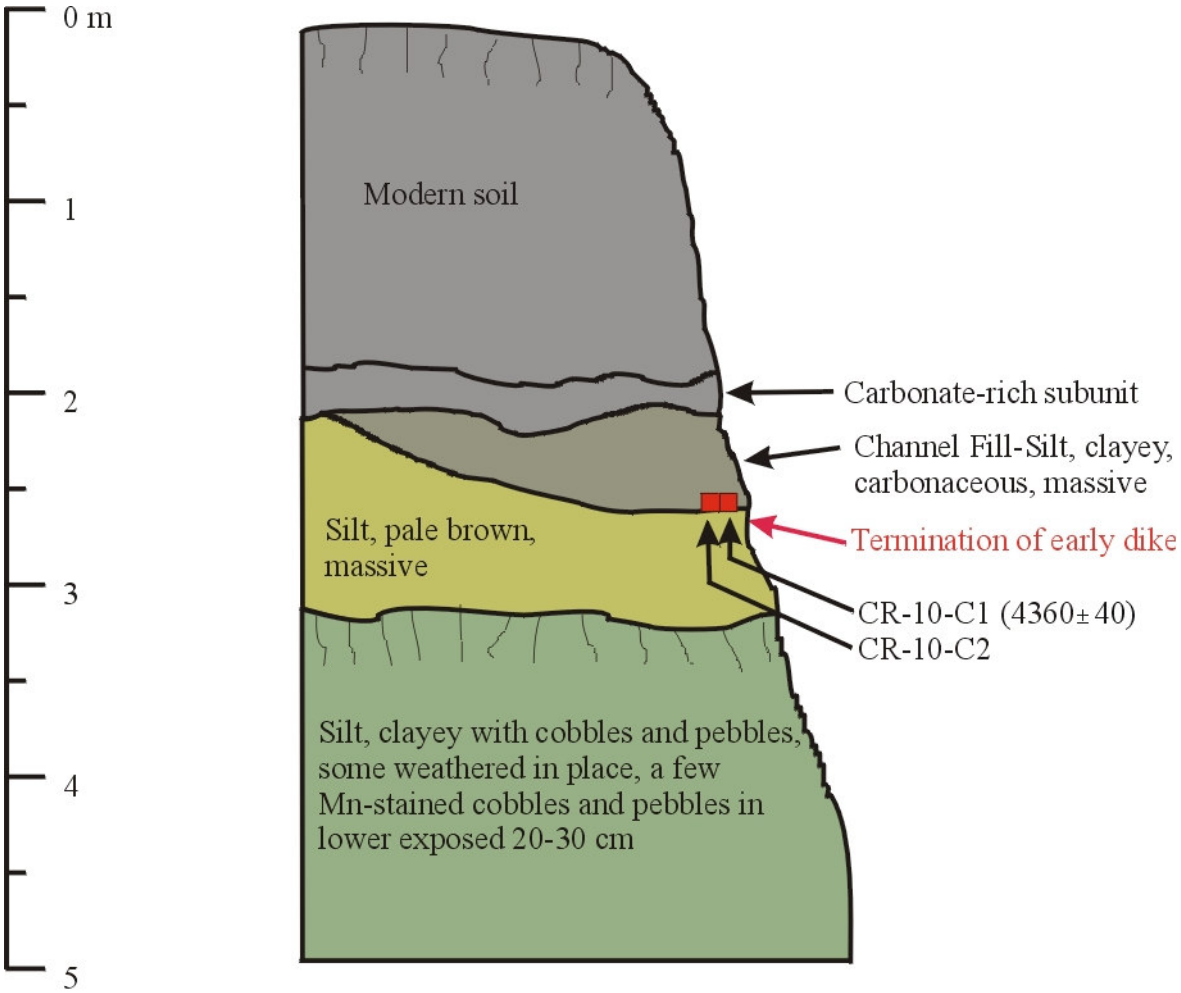
[2] Dike B consists of: Silt, gray, fine to medium grained; extends 4mm into soil

[3] Dike C consists of: Sand, silty, fine grained, Fe-stained

[4] Dike D consists of: Silt, gray, fine to medium grained

Calipooia River, Site CR-8

Reexamination of site CR-10 yielded two additional cross cutting dikes owing to additional erosion on the upstream side of the site (Figure 5). The two new dikes also terminate just below the carbonaceous channel fill unit in which we have one radiocarbon date from the 2002 field season. We were able to collect additional radiocarbon samples near the two new dikes. Additional radiocarbon dating of the new dikes is pending.



Notes: Two dikes present a 0.4-1 cm-wide silt dike cut by a 1-1.6 cm-wide silty fine-sand dike

Calipooia River Site CR-10

The exposure at site CR-13, found in 2002 contained two sand dikes with a maximum date of 600-560 BP, had been destroyed by erosion. We suspect now that the date obtained in 2002 represents an inset much younger terrace deposit similar to site CR-7. There is no trace of this deposit now. The erosion that destroyed site CR-13 exposed a new section (designated CR-14) of riverbank in which we found three sand dikes. No datable material was found at CR-14 (Figure 6).

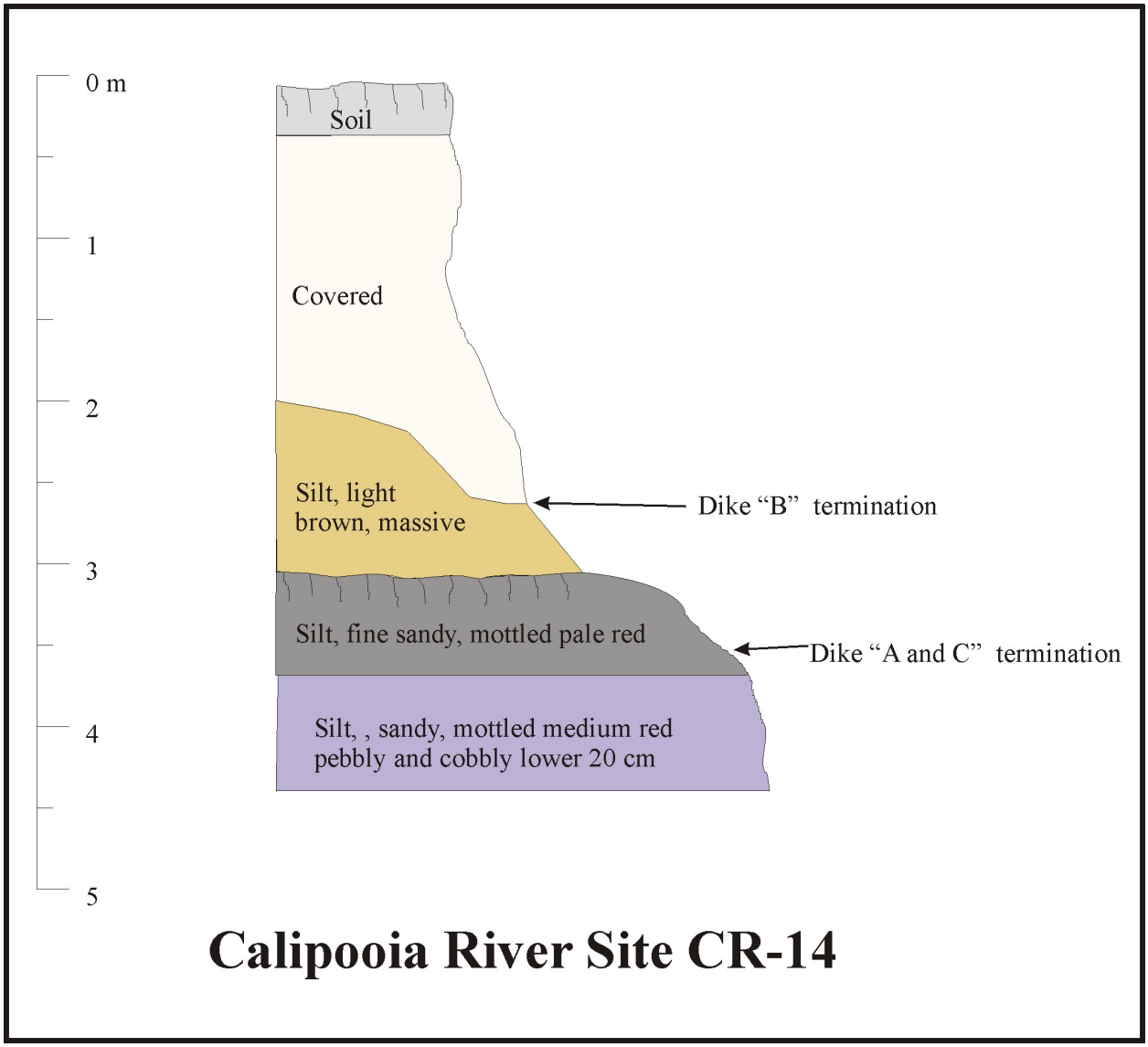


Table 1. Summary of Radiocarbon samples and dates related to paleoliquefaction features

Location	No. of Dikes	Events	Radiocarbon Samples	Radiocarbon Dates
CR-3	1	1	None	NA
CR-4	None	-		1060-790 Cal B.P.
CR-6	None	-		1960-1700 Cal. B.P.
CR-7	1	1	Detrital charcoal	900-850 and 810-680 Cal. B.P (Maximum age)†
CR-8	4	1?	none	NA
CR-10	2	2	Detrital charcoal	3090-2900 Cal. B.P. (Minimum age)
CR-13	1	1	Detrital charcoal	680-630 and 600-560 Cal. B.P. (Maximum age)†
CR-14	3	1?	None	Revisit of CR-13*

† This date represents a younger terrace material inset into the sand dike host and not the age of the dike

- CR-13 was revisited to look for additional datable material. The original site had been eroded away but the erosion had exposed additional sand dikes. However no datable material was found

Pudding River: We also completed a detailed canoe survey of the lower Pudding River totaling 22 km from near Whiskey Hill (Site PRR-18, UTM 10T-519314, 5002982) to near Canby (site PRR-20, UTM 10T-520452, 5011815. We also conducted auto and foot reconnaissance along about 54 km of the upper Pudding River from near Pratum (site PRR-1, UTM 10T-510464, 4978106) to near Whiskey Hill (site PRR-18, UTM 10T-519314, 5002982) , and about 70 km of the Tualatin River from near Cornelius(site TRR-9, UTM) to near Tualatin (site TRR-0, UTM 10T-516587, 5027188). Outcrops are generally good but they are generally of young inset terraces that tend to make the occurrence of sand dikes unlikely. We found that the banks of the Pudding River are generally well exposed and that there is extensive Holocene terrace deposits in most places inset into the Pleistocene fluvial and flood deposits.

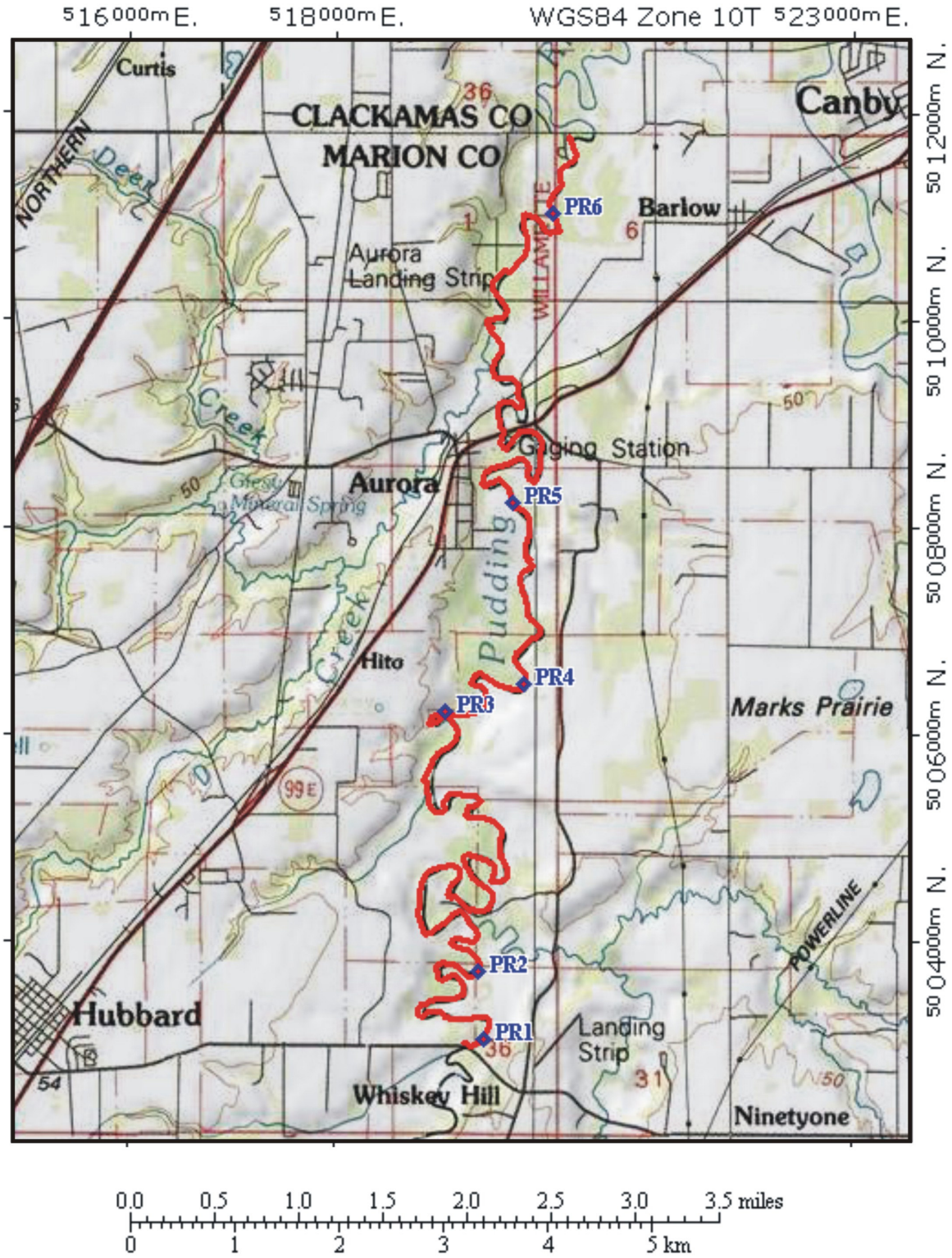
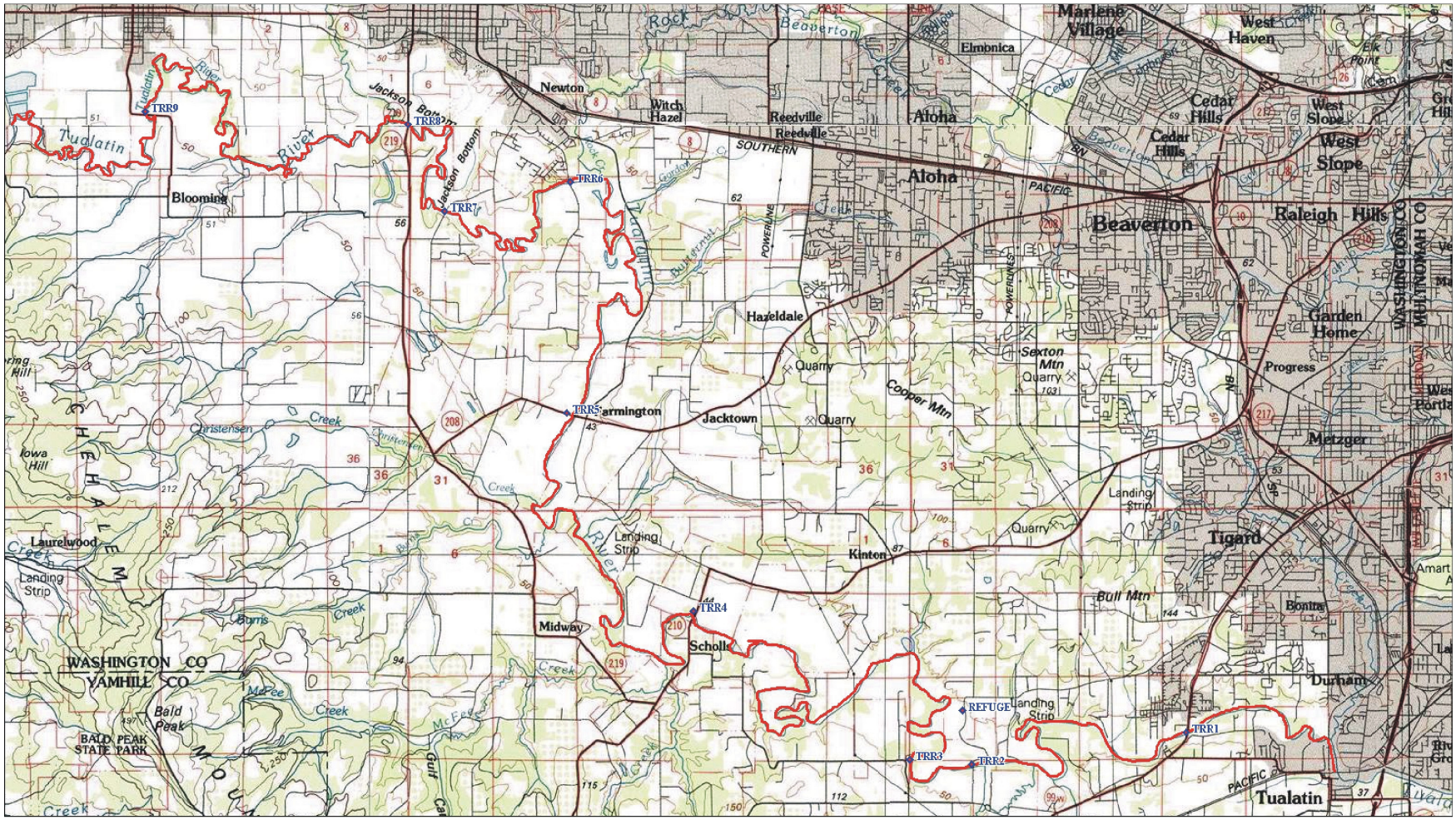


Figure 7. Map of canoe reconnaissance of the Pudding River from near Whiskey Hill to near Canby.

Tualatin River: We completed a detailed survey of the section of the Tualatin River between river miles 52 and 11. The Quaternary stratigraphy is well exposed and the river has numerous looping meanders that expose the section well in cutbanks. Cutbanks range in height from about 3 meters to >7 meters. Sediment is dominantly silt and fine sand, with lesser thicknesses of coarse sand and conglomerate. We will propose additional detailed canoe survey of this river.



Map created with TOPO!® ©2003 National Geographic (www.nationalgeographic.com/topo)

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Non-technical Summary

We completed detailed reconnaissance by canoe and raft totaling 135 km on the, Calapooia, Luckiamute, Pudding, Willamette, and South Fork Santiam rivers. We also conducted auto reconnaissance along about 40 km of the North Fork Santiam River, South Yamhill River from near Amity to it's mouth and the Tualatin River between miles 11 and 52. The surveys were conducted when the water level was low and cutbanks best exposed. The location of relevant features were measured with a global positioning system and marked on topographic base maps. Liquefaction features are described in terms of their size (width of dikes, and lateral extent and thickness of sand blows and sills), orientation, sedimentary structures, crosscutting relations, soil development, and stratigraphic context. Paleoliquefaction features were found in the cutbanks of the Calapooia River. The Luckiamute, Pudding, Willamette, and South Fork Santiam River did not yield exposures of paleoliquefaction features. Deposits in cutbanks of the North Fork Santiam River was found to nonconductive to the formation of paleoliquefaction features. Deposits exposed in cutbanks of the Tualatin River yielded promising exposures that we will propose to investigate at a later date.

Reports Published

None

No seismic, geodetic, or processed data have been generated by this project.