DATA REPOSITORY

to accompany GSA Bulletin manuscript:
Plate-Boundary Earthquakes and Tsunamis of the Past 5,500 Years,
Sixes River Estuary, Southern Oregon

DATA REPOSITORY I: ANALYSIS OF ^{14}C SAMPLES

We started our ^{14}C sampling of organic material from buried soils in 1990 and incrementally submitted more samples for ^{14}C analysis in succeeding years through 1999 (Table 2). Results from the first two years led us to be suspect of ^{14}C samples of unidentifiable wood fragments and herbaceous samples in general. In the case of the former, in the second year of sampling we submitted for age determination a sample of unidentified wood fragments (sample 94 BB 271.7, Table 4). This sample yielded an age that was 1,000 to 2,000 years older than was possible based on bracketing ^{14}C ages in the same core (Table 4). Subsequently, we collected only radiocarbon samples consisting of identifiable delicate woody detritus or seeds.

Also based on the first two years of age determinations, we concluded that herbaceous samples have the potential to yield anomalously young ages. From age results, we suspected a systematic difference in ages from samples of seeds or delicate detrital woody material (collectively called 'detrital woody' samples) versus herbaceous root or stem material. We evaluated these two sample types by dating both detrital woody and herbaceous material from the same buried soil at the same core site. We did this test for buried soil VI at the core J site, for buried soil VII at the core V site and for buried soil IX at the core J site (Table DR1). Results show that herbaceous ^{14}C samples yield ^{14}C ages that can be hundreds to almost a thousand years younger than detrital woody samples (Table DR1). It is the herbaceous samples and not the woody samples that provide ages that are chronologically out of sequence in comparison to ages from underlying and overlying buried soils within the same core (Table 4). A herb may yield an anomalously young age if the herb is a root that grew down into the soil from overlying sediment. Because we suspect that herbaceous ^{14}C samples yield problematic ages, radiocarbon samples collected after 1996 do not include herbaceous

samples. We did not use 1996 and earlier ^{14}C ages from herbaceous samples when computing estimated ages for buried soils except in two cases where we retained the herb ages because they were consistent with bracketing or equivalent woody ages and the field description indicated that the herb was a stem flattened on a buried soil contact. We infer that the herb stem was killed by deposition of tidal mud after rapid submergence of the soil. The two retained herb ages are for core GG at 111 cm depth and for core S at the 291 cm depth (samples 96 GG 111 and 93 S 291, Table 4).

As described in the text, ^{14}C age determinations for soils in individual cores (Table 4) were sorted into appropriate buried soil groups based on the correlation of buried soils throughout the abandoned meander wetland. Column two of Table DR2 shows all the ages sorted by buried soil. After grouping of ages by soil, we assessed whether ^{14}C ages within individual buried soil horizons were in proper chronologic order relative to ^{14}C ages sorted to stratigraphically higher and lower soil horizons. Ages that were eliminated had both of the following attributes, the ages were too young or too old and the ages came from the suspect sample types discussed above. Ages that were eliminated can de determined by comparing of columns two and three, Table DR2.

DATA REPOSITORY II: DIATOM BIOSTRATIGRAPHY AND DETERMINATION OF PALEO MEAN TIDE LEVELS

Figure 7 shows a relative sea level curve for the core J site. The curve depicts the fluctuation of mean tide level since ca. 5,000 years ago. The purpose of this data repository is to provide more complete documentation of how we used diatoms to determine paleo mean tide levels.

At core J we undertook a qualitative biostratigraphic analysis of diatom assemblages by sampling at specific depths in the core (Appendix DR1). The analysis relies on the observation that, in tidal marshes, specific diatom assemblages are limited to defined elevation ranges relative to mean tidal level (Hemphill-Haley, 1995) (Figure DR1). Diatom assemblages are assigned to one of four ecologic zones (tide flat, low marsh, high marsh, freshwater marsh/upland) that have overlapping elevation ranges (Figure DR1). The ecologic zones have assigned elevations ranges

relative to mean tide level (Figure DR1). We identified diatom assemblages immediately above and below buried soil contacts X, IX, VIII, VII and VI (Appendix DR1). By knowing the ecologic zonal shift associated with an instance of soil burial, we can estimate the magnitude of the associated rise in mean tide level (Table 6). The estimated rise in mean tide level is an estimate of the amount of submergence (Figure 7). To account for the elevation ranges of the diatom ecologic zones, both maximum and minimum submergence amounts are depicted on Figure 7.

Appendix DR1

Diatom Analyses for Sixes River Core J

Methods: Strewn slides for diatoms were prepared by cleaning approximately 0.5 cc of sediment with 30% hydrogen peroxide. After the reaction was compete (ca. 8 hours), the sample was rinsed several times with distilled water. An aliquot of the cleaned sediment slurry was placed on a 22 mm x 30 mm glass cover slip and affixed to glass slide with Hyrax mounting medium. Where possible, 100 diatoms per sample were counted at magnifications of 650x and 1250x along random traverses of the slide.

Sample: SXM95-J 70-70.5 cm
Description: fine detrital peat
Pertinent diatom species:
Environment: probably freshwater wetland
Special notes: preservation moderate to poor. Diatoms very rare and fragmented, though some large pennates are intact.
Counts: freshwater species, 100%

Sample: SXM95-J 140-140.5 cm
Description: coarse detrital peat
Pertinent diatom species: *Eunotia pectinalis*
Environment: probably freshwater wetland
Special notes: preservation very poor. Only very rare fragments observed.
Counts: 100% freshwater species (rare fragments only)

Sample: SXM95-J 190-190.5 cm
Description: blackish-brown fine peat
Pertinent diatom species:
Environment: probably freshwater wetland.
Special notes: preservation poor. Diatoms very rare, mostly fragments, exclusively freshwater.
Counts: freshwater species, 100%

Sample: SXM95-J 200-200.5 cm
Description: blackish-brown coarse peat
Pertinent diatom species:
Environment: indeterminate
Special notes: Diatoms absent, except for a few unidentifiable fragments.

Sample: SXM95-J 210-210.5 cm
Description: fine peat, more decomposed downward
Pertinent diatom species: *Pinnularia viridis, Pinnularia* spp., *Eunotia pectinalis, Stauroneis phoenicenteron*
Environment: freshwater wetland
Special notes: preservation moderate to poor. Diatoms fairly common.
Counts: freshwater species, 100%

Sample: SXM95-J 231-231.5 cm (Soil VI just after submergence)
Description: light brown organic clay
Pertinent diatom species: Fresh-brackish species include: *Navicula elegans, Fragilaria virescens* var. *oblongella, Navicula lanceolata,* other small *Navicula* spp. Brackish-marine species include: *Caloneis westii, Paralia sulcata, Tryblionella plana, Diploneis smithii* var. *rhombica, Navicula digitoradiata* var. *minor, Cocconeis scutellum* var. *parva*
Environment: probably estuarine tidal flat
Special notes: preservation good. Sample very rich, with abundant fresh-brackish species mixed with brackish-marine species, all well-preserved. This sample is very similar to sample SPF 95G 52-55 cm, a sandy, p freshwater species, 68%; brackish species, 32%

Sample: SXM95-J 234-234.5 cm (Soil VI just before submergence)
Description: dense dark brown peat
Pertinent diatom species: Dominant freshwater species include *Navicula elegans* and *Fragilaria virescens* var. *oblongella*. Brackish-marine species include *Cocconeis scutellum* var. *parva, Nitzschia scapelliformis, Navicula digitoradiata* var. *minor*.
Environment: freshwater wetland
Special notes: preservation moderate. Diatoms rare, but some well preserved. Freshwater species dominate, but three brackish-marine species were observed.
Counts: freshwater species, 97%; brackish species, 3%

Sample: SXM95-J 290-290.5 cm
Description: Stiff brownish gray clay.
Pertinent diatom species:*Rhaphoneis amphiceros, Paralia sulcata, Cocconeis scutellum, Melosira nummuloides, Caloneis westii, Delphineis* cf. *Surirella*.
Environment: brackish-marine tidal flat or shallow channel.
Special notes: preservation moderate to poor. Diatoms common, but most fragmented. The amount of fragmentation may indicate transport and redeposition.
Counts: freshwater species, 3%; brackish species, 97%

Sample: SXM95-J 295-295.5 cm
Description: Stiff brownish gray clay.
Pertinent diatom species: common *Pinnularia lagerstedtii, Caloneis bacillum*; rare *Paralia sulcata, Tryblionella plana*.
Environment: Probably brackish low marsh, or transition from low to high marsh.
Special notes: preservation moderate. Diatoms common relative to silt.
Counts: freshwater species, 6%; brackish species, 94%

Sample: SXM95-J 301 cm (Soil VII just after submergence)
Description: clayey fine sand
Pertinent diatom species: Freshwater species include *Eunotia minor, Pinnularia lagerstedtii,*

Cocconeis placentula. Brackish-marine species include *Paralia sulcata, Cocconeis scutellum* var. *parva, Achnanthes delicatula*
Environment: mix of estuarine tidal flat species with probable *in situ* freshwater wetland species – consistent with tsunami deposit
Special notes: preservation moderate. Mix of freshwater species and brackish-marine species
Counts: freshwater species, 32%; brackish species, 68%

Sample: SXM95-J- 304 cm (Soil VII just before submergence)
Description: clayey peat
Pertinent diatom species: Freshwater species include *Gomphonema parvulum, Synedra* sp., *Pinnularia lagerstedtii, Navicula radiosa, Achnanthes lanceolata, Epithemia sorex, Diademis contenta*. Rare brackish-marine species include *Paralia sulcata, Tryblionella granulata, Thalassiosira simonsenii* var. *minor*.
Environment: freshwater wetland
Special notes: preservation moderate to good. Diatoms rare but well preserved, dominated by freshwater species.
Counts: freshwater species, 91%; brackish species, 9%

Sample: SXM95-J 330 cm (Soil VIIa just after submergence)
Description: stiff light brownish gray clay
Pertinent diatom species: *Navicula cincta, Cosmioneis pusilla, Pinnularia lagerstedtii, Paralia sulcata, Gyrosigma eximium, Cocconeis scutellum, Nitzschia sigma*
Environment: brackish high marsh
Special notes: Dominated by brackish-marine species, including mix of high-marsh, low-marsh and tidal-flat species. Planktonic species common. Differs from sample at 333 cm by increase in lower-intertidal species, but diatom assemblage is not clearly indicative of a specific intertidal environment. This is consistent with mixing of allochthonous valves following a rapid rise in relative sea-level

In this and all succeeding samples, *Cosmioneis pusilla, luticola mutica,* and *Pinnularia lagerstedtii* are included as a separate group ("*Cosmioneis* group"). Although these species are found in freshwater wetlands, they are indicative of brackish high marshes (i.e., salt marshes above mean higher high water). Categorizing them only as freshwater species may skew the interpretation towards a less saline paleoecological setting than may have existed.
Counts: brackish species, 55%; *Cosmioneis* group, 45%

Sample: SXM95-J 333 cm (Soil VIIa just before submergence)
Description: stiff light brownish gray clay
Pertinent diatom species: *Cosmioneis pusilla, Pinnularia lagerstedtii, Navicula cincta* . Rare species include *Denticula subtilis, Nitzschia* spp., *Campylodiscus echineis, Thalassiosira pacifica, Delphineis surirella*.
Environment: probably brackish high marsh
Special notes: preservation moderate to good. Dominated by *Cosmioneis pusilla, Pinnularia lagerstedtii, Navicula cincta* . Brackish-marine planktonic species also present
Counts: freshwater species, 1%; brackish species, 30%; *Cosmioneis* group, 69%

Sample: SXM95-J 400 cm (Soil VIII just after submergence)
Description: sand
Pertinent diatom species:
Environment: sandy brackish tidal flat
Special notes: preservation good. Diatoms dominated by small brackish-marine epipsammon.

Counts: brackish species, 100%

Sample: SXM95-J 402 cm (Soil VIII just before submergence)
Description: grayish brown clayey peat
Pertinent diatom species: *Rhopalodia musculus*, *Navicula digitoradiata*, *Gyrosigma eximium*, *Caloneis bacillum*
Environment: brackish-marine deposit, possibly low marsh or marsh-edge flat
Special notes: preservation good
Counts: brackish species, 94%; *Cosmioneis* group, 6%

Sample: SXM95-J 434 cm (Soil IX just after submergence)
Description: stiff gray clay
Pertinent diatom species: *Paralia sulcata*
Environment: brackish-marine deposit, probably estuarine tidal flat or shallow channel
Special notes: preservation moderate to poor. Dominated by large *Paralia sulcata*, with common epipsammon and miscellaneous poorly preserved benthic diatoms.
Counts: brackish species, 100%

Sample: SXM95-J 440 cm (Soil IX just before submergence)
Description: dense blackish brown fibrous peat
Pertinent diatom species: *Pinnularia lagerstedtii*, *Pinnularia viridis*, *Achnanthes lanceolata*, *Eunotia* sp., *Rhopalodia gibba*, *Pinnularia obscura*, *Sellaphora pupula*
Environment: freshwater marsh
Special notes: preservation poor. Diatoms rare, and poorly preserved. Mostly broken freshwater pennate diatoms. Pollen and chrysophytes. Note that *Cosmioneis pusilla* is common, and in this case is probably indicative a freshwater marsh assemblage, as it does not co-occur with other species more indicative of high salt marshes.
Counts: freshwater species, 91%; brackish species, 3%; *Cosmioneis* group, 6%

Sample: SXM95-J 521 cm (Soil X just after submergence)
Description: brown woody peat
Pertinent diatom species: *Paralia sulcata*, *Tryblionella granulata*, *Tryblionella* spp., *Thalassionema nitzschioides*
Environment: brackish-marine (probably tidal flat or channel)
Special notes: preservation moderate to poor. Diatoms dominated by heavily silicified species like *Paralia sulcata* and *Tryblionella granulata*.
Counts: brackish species, 100%

Sample: SXM95-J 524 cm (Soil X just before submergence)
Description: brown woody peat
Pertinent diatom species: Freshwater diatoms dominated by *Fragilaria* spp., and also include *Pinnularia viridis*, *Navicula elegans*, *N. lanceolata*, *Frustulia vulgaris*. Brackish species include *Caloneis westii*, *Navicula digitoradiata*, *Paralia sulcata*, *Nitzschia sigma*.
Environment: probably freshwater wetland
Special notes: preservation moderate to good. This sample contains abundant freshwater pond species (comparable to assemblage observed at 515 cm), but with prominent and well-preserved brackish benthic diatoms also present.
Counts: freshwater species, 75%; brackish species, 8%; *Cosmioneis* group, 17%

Sample: SXM95-J 657 cm

Description: sand
Pertinent diatom species:
Environment: brackish-marine (tidal flat?)
Special notes: preservation poor. Diatoms very rare overall and poorly preserved, but only brackish species present.
Counts: brackish species, 100%

Sample: SXM95-J 663 cm
Description: sand
Pertinent diatom species:
Environment: estuarine tidal flat or channel
Special notes: preservation moderate to poor. Diatoms rare; dominated by brackish tidal flat species.
Counts: brackish species, 91%; *Cosmioneis* group, 9%

Sample: SXM95-J 665 cm
Description: fine sand
Pertinent diatom species:
Environment: estuarine tidal flat or channel.
Special notes: preservation moderate to poor. Diatoms rare; dominated by brackish tidal flat species.
Counts: brackish species, 95%; *Cosmioneis* group, 5%

Sample: SXM95-J 669 cm
Description: sand
Pertinent diatom species: *Opephora parva*, other small epipsammon
Environment: estuarine tidal flat or channel
Special notes: preservation moderate. Diatoms rare overall except *O. parva*. Other small epipsammon present but rare.
Counts: brackish species, 100%

Sample: SXM95-J 671 cm
Description: fine sand
Pertinent diatom species: *Opephora parva*, other small epipsammon
Environment: estuarine tidal flat or channel
Special notes: preservation moderate. Dominated by small brackish-marine epipsammon, but other common tidal flat or shallow subtidal species are also prominent.
Counts: brackish species, 100%

Sample: SXM95-J 675 cm
Description: coarse sand
Pertinent diatom species: *Opephora parva*, other small epipsammon
Environment: estuarine tidal flat or channel
Special notes: preservation moderate. Dominated by small brackish-marine epipsammon, but other common tidal flat or shallow subtidal species are also prominent.
Counts: brackish species, 100%

Sample: SXM95-J 680 cm
Description: fine sand
Pertinent diatom species: *Catenula adhaerens, Cocconseis scutellum, Paralia sulcata, Tryblionella acuminata, Delphineis karstenii*

Environment: estuarine tidal flat or channel
Special notes: preservation moderate. Diatoms not abundant, but preservation is good. Tidal-flat species are prominent.
Counts: brackish species, 100%

Sample: SXM95-J 685 cm
Description: sand
Pertinent diatom species: Prominent tidal-flat species, comparable to 680 cm.
Environment: estuarine tidal flat or channel
Special notes: preservation moderate to poor. Prominent tidal-flat species, comparable to assemblage at 680 cm.
Counts: brackish species, 100%

Sample: SXM95-J 690 cm
Description: sand
Pertinent diatom species:
Environment: probably estuarine tidal flat or channel
Special notes: preservation moderate to poor. Diatoms very rare; brackish-marine benthic species only.
Counts: brackish species, 100%

Sample: SXM95-J 691 cm
Description: sand
Pertinent diatom species:
Environment: probably estuarine tidal flat or channel
Special notes: preservation moderate to poor. Diatoms very rare; brackish-marine benthic species only.
Counts: brackish species, 100%

Sample: SXM95-J 693 cm
Description: sand
Pertinent diatom species:
Environment: probably estuarine tidal flat or channel
Special notes: preservation poor. Diatoms very rare; brackish-marine benthic species only.
Counts: brackish species, 100%

Sample: SXM95-J 695 cm
Description: grayish brown peaty clay
Pertinent diatom species: *Paralia sulcata, Tryblionella granulata, Nitzschia socialis, Achnanthes delicatula*
Environment: estuarine tidal flat?
Special notes: preservation moderate. Diatoms not common, but better preserved compared to assemblages in overlying sandy sediment. Brackish tidal flat species prominent. Assemblage not strongly supportive of paleo-marsh environment, as suggested by lithology.
Counts: brackish species, 100%

TABLE DR1. TEST OF ^{14}C SAMPLE TYPES USING HERBACEOUS VERSUS WOODY DETRITAL OR SEED SAMPLES FROM SAME STRATIGRAPHIC HORIZON AT SAME CORE SITE.

Core site and stratigraphic interval	Composition of ^{14}C sample	^{14}C age *
Test #1, Buried soil VI, core J, stratigraphic interval 295-303 cm		
J 295	herbaceous stems and/or roots	2678 ± 73
J 300-303	seeds	3250 ± 40
J 301-303	conifer needles, seeds, leaf fragments	3340 ± 50
Test #2, Buried soil VII, core V, stratigraphic interval 155 cm		
V 155A	herbaceous stems and/or roots	2200 ± 80
V155B	spruce needles	3175 ± 65
Test #3, Buried soil IX, core J, stratigraphic interval 435-454 cm		
J 441-454 †	herbaceous fragments	2665 ± 80
J 435-438 †	seeds, seed fragments	3900 ± 40

Note: This table shows that herbaceous versus detrital woody or seed samples at the same stratigraphic horizon at the same core site yield different ^{14}C ages. This table does not demonstrate which sample type is problematic. Based on multiple ^{14}C age determinations from different stratigraphic levels in the same core (cores J and V, Table 1), we infer that the herbaceous samples yield the problematic ages. See text.

* Uncertainty for ^{14}C age reported to one standard deviation.

† These two samples are from two different cores (93J and 95J) at the same core site. The depths are slightly different but the samples are from the identical stratigraphic level.

TABLE DR2. ^{14}C AGES FOR BURIED SOILS, UPPER AND LOWER MEANDER, SIXES RIVER VALLEY: ENTIRE SET VERSUS SET USED FOR AGE CALIBRATION

Buried soil number	Entire set of ^{14}C ages * (core letter designation) [composition of sample] †	Subset of ^{14}C ages § (core letter designation) [composition of sample] †
II	modern (MM) [DWD]	#
III (upper part of upper couplet)	2065±45 (GG) [DWD]	2065±45 (GG) [DWD]
	2070±45 (V) [DWD]	2070±45 (V) [DWD]
IV (lower part of upper couplet)	1250±40 (MM)[DWHM]	
V	1644±68 (D) [HRS]	2450±80 (A) [DWD]
	565±50 (T) [HRS]	2499±66 (A) [DWD]
	1864±69 (S) [HRS]	2520±40 (BB) [S]
	2305±45 (GG) [HRS]	
	2450±80 (A) [DWD]	
	2499±660 (A) [DWD]	
	2520±40 (BB) [S]	
	2820±65 (V) [UNIDWD]	
VI (upper part of lower couplet)	2710±55 (J) [BPS]	2880±50 (BB) [S]
	2880±50 (BB) [S]	2885±45 (GG) [S]
	2885±45 (GG) [S]	
VII (lower part of lower couplet)	2678±73 (J) [HRS] **	3175±65 (V) [DWD]
	3045±65 (J) [HRS]	3240±50 (BB) [S]
	2200±80 (V) [HRS]	3240±40 (MM) [DWD]
	3175±65 (V) [DWD]	3250±50 (J) [S]
	3240±50 (BB) [S]	3340±50 (J) [DWD]
	3240±40 (MM) [DWD]	
	3250±50 (J) [S]	
	3340±50 (J) [DWD]	
VIII	3419±67 (J) [DWD]	3419±67 (J) [DWD]
	3546±64 (V) [DWD]	3546±64 (V) [DWD]
IX	2665±80 (J) [HRS]	3732±89 (S) [HRS]
	3732±89 (S) [HRS]	3780±50 (MM) [DWD]
	3780±50 (MM) [DWD]	3864±63 (V) [DWD]
	3864±63 (V) [DWD]	3840±50 (JJ) [DWD]
	3840±50 (JJ) [DWD]	3875±55 (BB) [DWD]
	3875±55 (BB) [DWD]	3900±40 (J) [S]
	3900±40 (J) [S]	
	5170±60 (BB)[UNIDWF]	
X	4319±76 (J) [HRS]	4362±51 (J) [HRS]
	4398±70 (C/T) [DWD]	4398±70 (C/T) [DWD]
XI	4630±65 (BB)[DWD]	4630±65 (BB)[DWD]
XII	5205±65 (J) [DWD]	5205±65 (J) [DWD]

*For complete data on ^{14}C ages, see Table 4.

† DWD = delicate woody detritus; HRS = herbaceous roots and/or stems; DWHM = combined detrital woody and herbaceous material; BPS = bulk peat sample, S = seeds; UNIDWF = unidentified wood fragments.

§ After removal of samples composed of HRS, DWHM, UNIDWF, and BPS; see text for more explanation.

Based on stratigraphic arguments discussed in the text, buried soil II cannot be 'modern' (< 100 years before A. D. 1950). The sample must have been contaminated by modern wood detritus. Therefore, the 'modern' age is deleted from the set of ^{14}C ages in this column.

** ^{14}C sample is from horizon VIIa (see Figure 3), 30 cm below top of buried soil VII in core J.