

## U.S. GEOLOGICAL SURVEY RESEARCH SCIENTIST RECORD

- (1) NAME Brian F. Atwater
- (2) DATE PREPARED May 14, 2015
- (3) DUTY STATION Seattle, Washington
- (4) REGION Western
- (5) CLASSIFICATION Geologist GS-15/10
- (6) ENTRANCE ON DUTY 1973
- (7) LAST PROMOTION 1997
- (8) LAST RESEARCH GRADE PANEL REVIEW 2011

(9) EDUCATION

Stanford University	Geology	1969 - 1974	B.S. and M.S. 1974
University of Delaware	Geology	1976 - 1980	Ph.D. 1980

(11) PROFESSIONAL EXPERIENCE

(a) PRESENT ASSIGNMENTS

I'm a field geologist who digs up muddy clues to earthquake and tsunami hazards, and who presents the findings to broad audiences. My efforts along these lines began a quarter century ago with a focus on the Cascadia subduction zone. I remain active at Cascadia today but do much related work overseas as well. The overseas efforts began in 1988 in Chile and 1987 in Japan. They expanded after the 2004 Indian Ocean tsunami into capacity building South and Southeast Asia for USAID and UNESCO, Fulbright research in Indonesia, service for the National Research Council, and studies of tsunami potential in the Caribbean. In 2010 I branched further into advisory work on water and ecosystem issues for the State of California.

The "present assignments" below extend as far back as fiscal year (FY) 2005. The nominally international share of this work, now about one-quarter, peaked around three-quarters in 2006 and 2007. The percentages are fuzzy because the international work has supported public-safety efforts in the Pacific Northwest, and because the Pacific Northwest project has covered most of my overseas salary. Project chiefs: Craig Weaver (Pacific Northwest), USAID (Walter Mooney), Caribbean (Uri ten Brink), Sacramento – San Joaquin Delta (none).

## INTERNATIONAL WORK

The 2004 Indian Ocean tsunami, seemingly without precedent on most of the shores it hit, highlighted the need to seek forewarnings from recent geologic history. I sought and received support from international programs to encourage research of this sort by scientists, chiefly in South and Southeast Asia.

From: 2006 Through: 2007

### **USAID's Indian Ocean Tsunami Warning System Program**

This two-year aid effort included support for field training in geological hazard assessment for scientists from Indonesia, India, Sri Lanka, and Thailand, first in Chile and then in those South and Southeast Asian countries. I proposed this training, recruited candidates, and led seven field sessions of 2-3 weeks each that served a total of 50 scientists. Main scientific outcome was the finding, in Thailand, of sand sheets from pre-2004 tsunamis (publication 56). \$220k budget, intended mainly for trainees' travel and per diem, covered a token total of 6 pay periods of my salary.

From: 2009 Through: 2011 (3 months 2009, 3 months 2010, 1 month 2011)

### **Fulbright scholar, Indonesia**

Salary support from the Pacific Northwest project enabled this follow-on to the USAID project. Indonesia leads the world in tsunami risk. I mostly failed to answer my main research question there: Have great earthquakes happened on the subduction zone south of Java, population 135 million? However, I was able to team up with my main Indonesian host and an Australian colleague to provide 270 person-days of field training in 2009 for government scientists and graduate students. The training was supported by Australia's international agency. We selected the trainees from six workshops that we led in Java and Sulawesi. My host and I also led field training in Aceh under a UNESCO project in 2011 (section 14e). In addition, I led in adapting, for international use, an Indonesian tsunami-safety booklet UNESCO first published in English in 2010 (57), now available in French, Spanish, Arabic, and Urdu.

From: 2008 Through: continuing (5 months in all)

### **Awareness and assessment of earthquake and tsunami hazards of the Arabian Sea**

Further outgrowths of the USAID project. Increasingly focused on Pakistan, with financial support from USAID's Office of Foreign Disaster Assistance beginning in 2012. Included one week of field training in Aceh, in 2011, for nine scientists and an emergency manager from Pakistan (section 14e); and guidance and editing of a UNESCO collection of eyewitness accounts of the 1945 Makran tsunami (65).

From: 2008 Through: 2011 (1 month in all)

### **Assistance in Chile**

Field work with Chilean paleoseismologists on the potential for giant earthquakes on the coast between Valparaíso and Concepción (February 2008 and January 2011). Instructor, Latin American hazards course, Concepción (January 2011; section 14e). Member, tsunami advisory panel for Oficina Nacional de Emergencia del Ministerio del Interior (beginning May 2012; section 14c). Lead author of report on lasting erosional effects of the 1960 Chilean tsunami and predecessors (62).

## DOMESTIC WORK

From: 2006 To: 2011

### **Pacific Northwest Seismic Hazard Project**

*Outreach:* A dozen public talks yearly, on average, in U.S. venues (section 15). In 2007 these included IRIS-SSA lectures (section 14d). *Reviews:* Article for *Annual Review of Earth and Planetary Sciences* (pub. 55). National Research Council review of the nation's tsunami programs, 2008-2010 (section 14c). Review of Cascadia turbidite evidence in relation to U.S. national seismic hazard maps (61, 64). *Adviser:* Two dissertations and a Mendenhall postdoc on Puget Sound geology, and one paleoseismology postdoc from Japan (section 14d). *Lessons from Chile:* Media inquiries on U.S. implications of the M 8.8 Maule earthquake (February 2010). AGU Chapman Conference on giant earthquakes and their tsunamis (May 2010; section 14b). *Lessons from the Indian Ocean:* Press conference on Cascadia implications of Aceh-Andaman publication 56 (section 12a). Information exchanges between tsunami-education specialists from Indonesia and emergency personnel in Washington State (organizer and host, 2008 and 2010).

From: 02/08 To: Present

### **Tsunami hazard potential in the Caribbean**

Geological assessment of tsunami hazards in the northeast Caribbean, spurred in part by post-2004 concern that a giant earthquake along the Puerto Rico Trench would send a tsunami to nuclear-power-plant sites on the U.S. Atlantic seaboard. Led reconnaissance in 2008 and follow-up studies in 2009, 2011, 2012, 2013, 2014, and 2015 in an area 140 km east-northeast of Puerto Rico. Found evidence for overwash by the transatlantic 1755 Lisbon tsunami and for an earlier, probably near-source tsunami of medieval age. The latter finding offers the first strong evidence for generation of a tsunami by faulting on the subduction thrust or outer rise of the Puerto Rico Trench. Wrote initial report on findings from 2008 and 2009 (59) and edited four companion papers. In 2010 began advising a Ph.D. student on the staff of the Puerto Rico Seismic Network (which wants to develop in-house capabilities in tsunami geology). Uri ten Brink recruited me for the work and has facilitated its progress.

From: 09/10 To: Present

### **Sacramento – San Joaquin Delta**

Five-year term on a science board advising a California state agency, the Delta Stewardship Council. The state legislature charged the Council to help California meet the “coequal goals” of restoring Delta ecosystems and ensuring water exports. The Council's purview extends to catchments of the Sacramento and San Joaquin Rivers and to farms and cities that use their waters, including San Francisco and Los Angeles. The legislature mandated the science board to review all Delta science programs periodically and to review the environmental impact report for the Bay Delta Conservation Program, a proposed project of water exports and ecosystem rehabilitation. The board's ten members include fisheries biologists, river ecologists, and an environmental economist. I bring long-ago field experience with the estuary's geology and its wetland ecology (pubs. 1-15). Salary and travel supported by a USGS Delta project.

[http://www.deltacouncil.ca.gov/delta\\_science\\_program/isb/isb\\_intro.html](http://www.deltacouncil.ca.gov/delta_science_program/isb/isb_intro.html)

(b) PREVIOUS POSITIONS

I began my USGS career in 1973 with the Branch of Western Environmental Geology. I remained with that branch until 1995, when transferred to the Earthquake Program.

From: 10/85 To: 1/07 (continuation to 2011 in section 11a)

**Pacific Northwest earthquake and tsunami hazards.** Studies of subsidence, tsunamis, and liquefaction from earthquakes on the Cascadia subduction zone; of modern analogs in Chile and Alaska; of written records of the 1700 Cascadia tsunami in Japan; and of the Seattle earthquake of AD 900-930. Public outreach. \$335k from Nuclear Regulatory Commission (1987-1993). Defined scientific problems and strategies under nominal supervision from Craig Weaver and, before megaprojects, from branch chiefs Art McGarr, Jack Hillhouse, Rowland Tabor, and Bob Castle.

From: 2/84 To: 9/85

**Earthquake recurrence near Coalinga.** Holocene alluvial stratigraphy across an anticline that grew during the Coalinga earthquake of May 1983. Recruited by Ross Stein. Work carried out in collaboration with John Tinsley.

From: 2/80 To: 9/85

**Geology of the Colville Indian Reservation, northeast Washington.** Mapping of crystalline and volcanic rocks in support of mineral exploration. Ancillary study, on my own initiative, of glacial-lake deposits in the map area. Assigned to the project by Doug Morton, when he was chief of the Branch of Western Environmental Geology. Mentored by Ken Fox and by project chief Dean Reinhart. Funding from Bureau of Indian Affairs.

From: 2/81 To: 9/82

**Quaternary geology of the San Joaquin Valley.** Alluvial fans of the Mokelumne, Tuolumne, and Kings Rivers, and of Marsh and Los Gatos Creeks. Response of Tulare Lake to glacial and interglacial climates. An upstream extension of my Ph.D. research in the Sacramento – San Joaquin Delta. Collaboration with Bill Lettis under project headed by Denis Marchand.

From: 6/77 To: 1/81

**Quaternary geology of the Sacramento - San Joaquin Delta.** Botany of modern Delta wetlands; surficial deposits in the Delta and on adjoining floodplains. Doubled as my dissertation research, which in turn grew out of the San Francisco Bay research below.

From: 9/73 To: 6/77

**Quaternary sea levels at San Francisco Bay.** Estuarine stratigraphy, tidal-marsh ecology, amino-acid ages of Pleistocene oysters. Led the research with mentoring from Ed Helley, Ken Lajoie, Andrei Sarna-Wojcicki, and others.

## (12) SIGNIFICANT RESEARCH ACCOMPLISHMENTS

### (a) MAIN ACCOMPLISHMENTS

**Pacific Northwest earthquake hazards.** I pioneered today's consensus that the northwestern United States and adjacent Canada are subject to Cascadia plate-boundary earthquakes as large as magnitude 9. My role began at a time when geophysicists were debating Cascadia's great-earthquake potential. A background with the geology and botany of estuaries (publications 1, 2, 5, 9, 12, 15) helped me recognize tidal-wetland records of the region's earthquake-induced subsidence and tsunamis. Publication 23 reported such records from Washington State, and other geologists soon followed suit in British Columbia, Oregon, and California (initial review, publication 33). Collectively our dispersed findings showed that the subsidence ranged too far along the coast to have resulted from faults other than Cascadia's plate boundary. Radiocarbon ages of uncommon geological and analytical precision soon showed that the most recent giant Cascadia earthquake (or series of lesser earthquakes) occurred in the decades between 1680 and 1720, through an initiative that the Nuclear Regulatory Commission funded and which I led (26) or co-led (36). Those decades include a January 1700 tsunami of unknown origin that Japanese earthquake and tsunami historians had been cataloguing since the early 1940s. Citing the 1680-1720 window, Japanese researchers proposed that Cascadia had produced a giant earthquake in January 1700. I worked closely with tree-ring scientists who soon dated the most recent coseismic subsidence in southwest Washington to the months between August 1699 and May 1700 (38, 44). Additional Cascadia contributions: discovery of archaeological sites and subsequent collaboration with archaeologists in showing that the 1700 tsunami overran North American fishing camps (37); estimation of earthquake-recurrence intervals, in collaboration with a micropaleontologist (27, 39, 48); supporting comparisons with modern analogs from Chile and Alaska (28, 43, 53); documentation of onshore evidence for shaking from great Cascadia earthquakes (30) and its interpretation by means of a Japanese demonstration project that I hosted (50); weaving these various strands into a general-interest book prepared with four Japanese researchers and a Japanese-American tree-ring scientist (52); skeptical review of earthquake histories recently inferred deep-sea turbidites (61). My Cascadia findings in the late 1980s and early 1990s contributed to regional revisions of seismic hazard maps and upgrades of existing buildings and bridges – early impact that helped defend the USGS earthquake program during the Gingrich Congress (35). Societal response to the Cascadia consensus now extends to many of the tsunami-preparedness efforts reviewed in publication 60, and to science curricula in Pacific Northwest schools (54). Recently I have called attention to overly enthusiastic interpretations of deep-sea turbidites as guides to Cascadia hazards (61, 64).

**Earthquake and tsunami hazards elsewhere on the Pacific Rim.** My studies in Japan and Chile, though meant to clarify hazards at Cascadia, ended up illuminating hazards in those countries as well. In Hokkaido I played supporting roles in showing that the southern Kuril Trench has a geologic history of earthquakes and tsunamis larger than those in that region's 200 years of written history (45, 47, 49). The finding is reflected mainly in Hokkaido's tsunami-hazard maps, which show a line for infrequent outside tsunamis. In southern Chile I helped confirm previous geophysical deductions that the giant 1960 earthquake incubated several times longer than the average recurrence interval for historical great earthquakes in the area (53).

**Infrequent recurrence of Aceh-Andaman earthquakes.** A USAID team (section 11a) uncovered evidence that the 2004 tsunami had incubated for 500-700 years. The evidence, reported in publication 56, consists of sand sheets in Thailand. I mentored the first author (section 19), participated in the field work, prepared most of the manuscript, and edited a companion paper on sand sheets in Aceh. Also I initiated a U.S. press conference at which the two papers' publication in *Nature* served as a reminder of infrequent catastrophes at Cascadia and occasioned updates from scientists and emergency managers from Washington, Oregon, and California.

**Tsunami-safety booklets.** Social scientists say that people are less likely to deny a threat if offered ways of dealing with it. This idea underlies two booklets on tsunami survival (40 and 42; 57). Both rely on journalistic retelling of eyewitness accounts, and both are featured on websites of the International Tsunami Information Centre and the Intergovernmental Oceanographic Commission.

*Publications 40 and 42* (in English and Spanish, respectively) use accounts of the 1960 Chilean tsunami in its near field (Chile) and far field (Hawaii, Japan). I led a project (section 14f) that brought home the Chilean accounts in 1989. Later, after finding the accounts useful in public talks, I asked the nascent National Tsunami Hazard Mitigation Program to support making the accounts into a booklet. An NTHMP State representative championed the idea, as did USGS editors Peter Stauffer and Jim Hendley. Initial print runs of 50,000 (publication 40) and 5,000 (42) provided states and counties with copies for distribution at coastal workshops. Revised versions followed the 2004 tsunami. Chile's Servicio Hidrográfico y Oceanográfico de la Armada published a spinoff in 2000, as did UNESCO's Santiago office in 2010.

*Publication 57* is based on an Indonesian-language booklet that publications 40 and 42 inspired. While in Indonesia in 2009 and 2010, I led in its adaptation for international use through the Jakarta Tsunami Information Centre, an arm of UNESCO's Intergovernmental Oceanographic Commission. The booklet provides Indonesian perspectives on near-field tsunami hazards. Struggling with nuances of culture and religion, I rewrote most of the text, added notes and references, and prepared the booklet's maps and graphs. State emergency agencies in Oregon and Washington received part of an initial print run of 55,000 that NOAA funded through the International Tsunami Information Centre in Honolulu. Translated into Spanish under a European Commission project and into French by the IOC. I edited both translations. Their printing is on hold because of a UNESCO budget crisis.

## (b) OTHER ACCOMPLISHMENTS

**Overwash northeast of Puerto Rico.** The Caribbean field work that I led in 2008 and 2009 yielded geological evidence for unusual overwash, probably by the 1755 Lisbon tsunami (59). Further findings distinguished between storm and tsunami deposits and pointed to the outer rise or subduction thrust along Puerto Rico Trench as a near-field tsunami source (63)

**Earthquake sources at Puget Sound.** I helped show that an active fault runs beneath downtown Seattle by discovering nearby signs of a Puget Sound tsunami (29). Also I solicited and edited four companion reports that appeared together in *Science*. The findings spurred study of shallow crustal structures in the Puget Sound and Portland areas and boosted awareness Puget Sound earthquake and tsunami hazards.

**Earthquake recurrence near Coalinga.** With John Tinsley and Ross Stein, I used alluvial-fan deposits to estimate that thousands of years, at a minimum, elapsed on average between Holocene earthquakes like the one that caused a fold to grow in 1983 (21).

**Geology of the Colville Indian Reservation,** northeast Washington. I contributed 1/5 of the geologic mapping of the 5000-km<sup>2</sup> reservation (18, A1). Mentored by Ken Fox and Dean Rinehart.

**Floods from glacial Lake Missoula.** While mapping bedrock on the Colville Reservation in the early 1980s I found evidence in support of Richard Waitt's then-controversial idea that Lake Missoula had issued dozens of floods during the last glaciation (17). I soon made what is still the fullest reconstruction of their number and frequency (20, 22), and I led a later defense of Waitt's idea (41).

**Tidal wetlands and Quaternary deposits of the Sacramento - San Joaquin Delta.** Reports 5, 9, and 15 are standard references on these topics. The maps in 15 serve as guides to the Delta's natural drainage networks and to the geological foundations of its man-made levees.

**Late Cenozoic geology of the San Joaquin Valley.** Lacustrine and alluvial-fan deposits indirectly date the most recent ice-cap glaciation of the southern Sierra Nevada (19).

**Quaternary geology of San Francisco Bay.** Holocene sea levels, Pleistocene stratigraphy, and rates of late Quaternary subsidence (2, 6); vertical zonation of modern tidal marshes (1, 5); bay-mud thickness map (4); correlation of Pleistocene oyster shells by means of amino acids (13). Mentored by Ed Helley, Andrei Sarna-Wojcicki, Ken Lajoie, and John Wehmiller.

### (13) SCIENTIFIC LEADERSHIP

I have provided leadership through research, mentoring, and public outreach. My research findings have spurred related studies by colleagues, shaped research programs in the USGS, underpinned emergency preparedness by other government agencies, and influenced capacity-building efforts by USAID and UNESCO. I have mentored graduate students in the Pacific Northwest and professional scientists overseas. On public outreach, please see section 15.

**Pacific Northwest.** My research has advanced the understanding of earthquake and tsunami hazards in the Pacific Northwest (section 12a). The Cascadia work has influenced earthquake and tsunami programs in the region since the late 1980s, and contributions at Puget Sound have helped spur investigations of its crustal faults since the early 1990s. Senior managers involved me in defending the USGS earthquake program through a 1994 fact sheet (35; section 15, p. 19) and in advancing a USGS hazards initiative through a May 2005 talk before House of Representatives staffers (in a session organized by David Applegate and Patrick Leahy). In the National Academy of Sciences I led a campaign that broadened a National Research Council review of the nation's tsunami programs to include risk assessment and to examine preparations for near-field tsunamis as well as for tsunamis generated far from U.S. coasts (section 14c, p. 11). For the U.S. National Seismic Hazard Maps I led a recent review of deep-sea turbidite evidence for earthquake size and frequency at the Cascadia subduction zone (61, 64).

**Overseas.** I have represented the United States as a leader in research and mentoring in Chile,

Japan, Indonesia, Thailand, India, Sri Lanka, Oman, and the Caribbean (sections 11a, 14e, 15, 19). The research clarified earthquake and tsunami hazards in Chile and Japan and on Indian Ocean shores (section 12a). The mentoring helped establish and sustain hazards research and outreach by Chilean, Indonesian, and Thai geologists (Thai example, section 19). It continued into 2012 with Pakistanis under a UNESCO and OFDA projects (section 14e).

## (14) SCIENTIFIC AND PUBLIC SERVICE

### (a) CURRENT MEMBERSHIPS IN PROFESSIONAL SOCIETIES

**Member.** American Geophysical Union, Geological Society of America, Seismological Society of America

### (b) TECHNICAL PRESENTATIONS

#### **Convener or co-convener**

AAAS sea-level session, annual meeting, February 2012, Vancouver, B.C.. The session hit home because 250,000 people already depend on dikes to keep high tides out of their neighborhoods on the Fraser River delta. The session made the front page in Vancouver Sun on 2/20. I led in proposing and organizing the session on behalf of the U.S. National Committee for IUGG.

AGU Chapman conference on giant earthquakes and their tsunamis, 2010 (58). Lead convener. Arranged travel support through UNESCO from participants from Indonesia, Iran, and Pakistan (a no-show).

GSA Penrose conference about great Cascadia earthquakes, 2000. One of five co-conveners, led by John Clague.

National Science Foundation workshop on tsunami geology, 2005 (51). One of three co-conveners led by Joanne Bourgeois. I recruited 15 overseas participants and took them on a coastal field trip that included field geology, a meeting with emergency responders, and an evening tsunami-safety workshop for the public.

Quaternary Research Center (University of Washington) conferences on tsunami geology, 2005 (with Joanne Bourgeois); Puget Sound earthquake hazards, 1993 (with Craig Weaver and Stephen Porter); and great Cascadia earthquakes, 1988.

Sessions at fall AGU meetings in 2009 (NH53B, Extreme natural hazards), 2007 (S24A, Earthquakes and tsunamis of the eastern Indian Ocean), 2005 (T11A, Subduction-zone paleoseismology on the Pacific Rim), and 1987 (on Cascadia).

#### **Presenter**

The abstracts listed below are from regular society meetings only. A33 and A34 were invited, as were the presentations in section 15. I find no record of abstracts before 1985.

- A1. Atwater, B.F., 1985, Contemporaneity of the Republic Graben and Okanogan Gneiss Dome; evidence from the Coyote Creek Pluton, southern Okanogan County, Washington. Geological Society of America Abstracts with Programs, v. 17, no. 6, p. 338.

- A2. Atwater, B.F., Tinsley, J.C., Stein, R.C., Trumm, D.A., Tucker, A.B., Donahue, D.J., Jull, A.J.T., 1985, Progress toward estimation of earthquake recurrence at Coalinga Anticline, California. *Eos (Transactions, American Geophysical Union)*, v. 66, no. 46, p. 1093.
- A3. Atwater, B.F., 1986, Number, frequency and relative magnitude of last glacial floods from Pleistocene Lake Missoula, Montana; evidence from the Sanpoil River valley, northeastern Washington. *Proceedings of the Pacific Division, American Association for the Advancement of Science*, v. 5, Part 1, p. 21.
- A4. Atwater, B.F., 1986, Holocene subduction earthquakes in coastal Washington. *Eos (Transactions, American Geophysical Union)*, Fall Meeting Supplement, v. 67, no. 44, p. 906.
- A5. Nelson, A.R., Atwater, B.F., Grant, W.C., 1987, Estuarine record of Holocene subduction earthquakes in coastal Oregon and Washington, U.S.A. *Congress of the International Union for Quaternary Research*, v. 12, p. 231.
- A6. Atwater, B.F., 1987, Aperiodic Holocene recurrence of widespread, probably coseismic subsidence in southwestern Washington. *Eos (Transactions, American Geophysical Union)*, Fall Meeting Supplement, v. 68, no. 44, p. 1468.
- A7. Atwater, B.F., 1989, Potential stratigraphic record of great historical earthquakes along the Rio Maullin, south-central Chile. *Geological Society of America Abstracts with Programs*, v. 21, no. 5, p. 52.
- A8. Atwater, B.F., Obermeier, S.F., Tabaczynski, D.A., Pond, E.C., Martin, J.R., Ho, C.L., 1991, Holocene shaking in southern coastal Washington. *Eos (Transactions, American Geophysical Union)*, v. 72, no. 44, p. 313.
- A9. Atwater, B.F., Stuiver, M., Yamaguchi, D.K., 1992, Radiocarbon test of earthquake magnitude at the Cascadia subduction zone. *Program and Abstracts, American Quaternary Association Conference*, v. 12, p. 4.
- A10. Atwater, B.F., 1992, Prehistoric earthquakes in western Washington. *Geological Society of America Abstracts with Programs*, v. 24, no. 5, p. 4.
- A11. Atwater, B.F., 1992, A Seattle tsunami 1100 years ago. *Geological Society of America Abstracts with Programs*, v. 24, no. 5, p. 4.
- A12. Atwater, B.F., 1993, A tsunami about 1000 years ago in Puget Sound, Washington. U. S. Geological Survey, Seattle, WA, United States, Canadian. *Quaternary Association, Applied Quaternary Research, Program with Abstracts and Field Guide*, p. A1.
- A13. Nelson, A.R., Atwater, B.F., Bradley, L.-A., Stafford, T.W., 1994, AMS 14C correlation of subsided wetland soils using rooted-herb and detrital samples in the Cascadia subduction zone. *Geological Society of America Abstracts with Programs*, v. 26, no. 7, p. 523.
- A14. Atwater, B.F., 1994, Subduction-earthquake telltales beneath coastal lowlands. *Geological Society of America Abstracts with Programs*, v. 26, no. 7, p. 239.
- A15. O'Connor, J.E., Pierson, T.C., Turner, D., Atwater, B.F., Pringle, P.T., 1996, An exceptionally large Columbia River flood between 500 and 600 years ago; breaching of the Bridge-of-the-Gods landslide? *Geological Society of America*

Abstracts with Programs, v. 28, no. 5, p. 97.

- A16. Atwater, B.F., 1996, Checklist for downsizing the greatest Cascadia earthquakes: Geological Society of America Abstracts with Programs, v. 28, no. 5, p. 44.
- A17. Atwater, B.F., Hemphill-Haley, E., 1997, Recurrence intervals for great earthquakes in coastal Washington: Geological Society of America Abstracts with Programs, v. 29, no. 6, p. 131.
- A18. Barnhardt, W.A., Kayen, R.E., Atwater, B.F., 1998, Radar-based stratigraphic records of the 1964 Alaskan earthquake. Geological Society of America Abstracts with Programs, v. 30, no. 7, p. 398.
- A19. Atwater, B.F., 1999, Radiocarbon dating of a Seattle earthquake to A.D. 900-930: Seismological Research Letters, v. 70, no. 2, p. 232.
- A20. Atwater, B.F., 1999, Prehistoric earthquakes at Cascadia: Seismological Research Letters, v. 70, no. 2, p. 210.
- A21. Hagstrum, J.T., Atwater, B.F., 2000, Geomagnetic secular variation recorded by Holocene estuarine deposits related to major earthquakes of the Pacific Northwest (Washington and Oregon): Eos (Transactions, American Geophysical Union), Fall Meeting Supplement, v. 81, no. 48, Abstract GP72A-06.
- A22. Atwater, B.F., Haraguchi, T., Takada, K., Satake, K., Shimokawa, K., 2001, Sand sills in huge cores along the Columbia River, Washington: Seismological Research Letters, v. 72, no. 2, p. 254.
- A23. Whisler, J.E., Atwater, B.F., Montgomery, D.R., 2002, Holocene liquefaction near the Seattle Fault at the Issaquah Creek delta. Eos (Transactions, American Geophysical Union), Fall Meeting Supplement, v. 83, no. 47, Abstract S22B-1036.
- A24. Atwater, B.F., Ikeda, Y., Satake, K., 2002, Chilean analog for 17th-century uplift along the southern Kuril Trench. Eos (Transactions, American Geophysical Union), Fall Meeting Supplement, v. 83, no. 47, Abstract G61A-0965.
- A25. Takada, K., Satake, K., Shimokawa, K., Atwater, B.F., Haraguchi, T., 2002, Geoslicing and liquefaction along the Columbia River at Hunting Island, Washington. Seismological Research Letters, v. 73, no. 2, p. 247.
- A26. Satake, K., Wang, K., Atwater, B.F., 2002, Magnitude 9 persists for the 1700 Cascadia earthquake. Seismological Research Letters, v. 73, no. 2, p. 241.
- A27. Mayrose, L.A., Patterson, G., Schweig, E.S., Haraguchi, T., Satake, K., Takada, K., Shimokawa, K., Atwater, B.F., Okumura, K., Tuttle, M.P., Haynes, M., Payne, C., Hoffman, D., 2002, Geoslicer sampling of liquefaction in the New Madrid seismic zone, central United States: Seismological Research Letters, v. 73, no. 2, p. 247.
- A28. Atwater, B.F., Satake, K., Tsuji, Y., Ueda, K., Yamaguchi, D.K., 2002, Japan's Chilean clues to earthquake size at Cascadia: Seismological Research Letters, v. 73, no. 2, p. 240.
- A29. Youlton, C., Atwater, B., Cisternas, M., 2003, Westward decrease in postseismic uplift in the region of the 1960 Chile earthquake: Geological Society of America Abstracts with Programs, v. 35, no. 6, p. 584.
- A30. Salgado, I., Eipert, A., Atwater, B., Shishikura, M., Cisternas, M., 2003, Recurrence of

- giant earthquakes inferred from tsunami sand sheets and subsided soils in south-central Chile: Geological Society of America Abstracts with Programs, v. 35, no. 6, p. 584.
- A31. Cisternas, M., Atwater, B., Machuca, G., Lagos, M., 2003, Buried soils, tree rings, and old maps suggest that the 1960 Chile earthquake was larger than its predecessors of 1837 and 1737: Geological Society of America Abstracts with Programs, v. 35, no. 6, p. 478.
- A32. Atwater, B.F., Satake, K., 2003, The 1700 Cascadia tsunami initiated a fatal shipwreck in Japan. Geological Society of America Abstracts with Programs, v. 35, no. 6, p. 478.
- A33. Atwater, B.F., Cisternas, M., Salgado, I., Machuca, G., Lagos, M., Eipert, A., Shishikura, M., 2003, Incubation of Chile's 1960 earthquake. Eos (Transactions, American Geophysical Union), v. 84, no. 46, Fall Meeting Supplement, Abstract G22E-01 (invited).
- A34. Atwater, B.F., Goldfinger, C., Nelson, C., 2004, Onshore-offshore correlation of geologic evidence for great Cascadia earthquakes – permissive agreement between Washington estuaries and Cascadia deep-sea channel: Eos (Transactions, American Geophysical Union), v. 85, no. 47, Fall Meeting Supplement, Abstract T12B-01 (invited).
- A35. Atwater, B.F., 2004, Master cycles of land-level change and great-earthquake recurrence in Cascadia, northeast Japan, and southern Chile: Eos (Transactions, American Geophysical Union), v. 85, no. 47, Fall Meeting Supplement, Abstract G13C-03.
- A36. Tuttle, M., Alam, S., Atwater, B., Charoentitirat, T., Charusiri, P., Choowon, M., Fernando, S., Jankaew, K., Jittanoon, V., Kongko, W., Maxcia, C., Pailoplee, S., Phantu Wongraj, S., Rajendran, K., Rhodes, B., Srichan, N., Tejakusuma, I., Yulianto, E., 2007, Searching for Pre-2004 tsunami deposits in Thailand. Eos (Transactions, American Geophysical Union), v. 88, no. 23, Joint Assembly Supplement, Abstract T43B-04.
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2010.

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(c) RENDERING SCIENTIFIC JUDGMENT

**National Research Council Committee on Tsunami Warning and Preparedness, 2008-2010.** I led lobbying that broadened this review's scope, and I served on a difficult committee. The Tsunami Warning and Education Act of 2006 required, from the National Academy of Sciences, a review of NOAA's progress under the Act. The congressionally mandated review was to focus on tsunami detection and forecasting applicable mainly to shores far from tsunami sources. When the National Research Council announced plans for this review, Earth scientists in NAS objected. Citing near-field hazards at Cascadia, Alaska, and the Caribbean, I led in requesting that the review extend to tsunami education and to assessment of tsunami hazards and vulnerability. The NAS president responded by directing the National Research Council to carry out such a broadened review, and he provided NAS funds to make this review possible. The committee struggled with its hybrid charges, with personnel issues that led to two resignations, and with deadlines missed partly because NAS diverted the study director to a higher-priority panel on climate change. I contributed most to the report (60) by helping to persuade the chairs and study director to allow an additional round of major revision by the full committee.

**National Research Council Committee on State of the Art and Practice in Earthquake Induced Soil Liquefaction Assessment, 2013-2015.** I served as the sole geologist on an 11-member committee. As of May 2015 the committee's report was undergoing final revisions before being sent out for review.

**Oficina Nacional de Emergencia del Ministerio del Interior, Chile,** committee of experts on earthquakes and tsunamis. A newly formed committee, May 2102. Occasional advice for Chile's FEMA, by e-mail and teleconference.

**Delta Independent Science Board,** term 2010-2015. Reviews of science and science programs in the thick of California water politics (section 11a). At least four weeks yearly.

**U.S. National Committee for the International Union of Geodesy and Geophysics,** 2009-2012. Member since 2009 representing the National Academy of Sciences; reappointed for a second 3-year term, 2011. Contributed to the committee's proposals for special sessions at AGU (hazards), AAAS (science diplomacy), and IUGG (sea-level rise). Convened AAAS session on sea-level rise, 2012. NSF suspended the committee's funding in 2012 and resumed it in 2015.

**Scientific Committee, International Seismic Safety Commission, International Atomic Energy Agency, 2009.** The ISSC is "to assist IAEA Member States in external hazard assessment and in aspects of site selection and site evaluation" (<http://www-ns.iaea.org/tech-areas/seismic-safety/default.asp?s=2&l=13>). I am one of two geologists on the Scientific Committee, an advisory group recruited in 2008. I attended one ISSC meeting, in 2009, in which almost one-quarter of the attendees were from Japanese electric-power companies. At the time I knew of geological and geophysical evidence for a Tohoku hazard greater than previously thought. I reported on geological evidence for infrequent outside tsunamis in Thailand (56) without relating it to Tohoku. The committee has not reassembled since the 2011 Fukushima disaster.

**Review Panel for Geology, USGS Mendenhall Program, 2009.** Evaluated 40 postdoc proposals over the winter holidays.

**Science Advisory Board, Earth Institute of Singapore (EOS), Nanyang Technological University, 2009-2011.** The board advises EOS director Kerry Sieh on scientific directions, hiring, development of an undergraduate program, in-house research proposals, and management issues. I missed the 2009 meeting (to carry out field work in the Caribbean) but attended all three since. Mine is one of the voices for EOS as a team player in its dealings with scientists from neighboring countries.

**Dean's Advisory Council, College of the Earth, Oceans, and Environment, University of Delaware, 2009 to present.** On my own time and at my own expense; alumni service.

**NOAA Science on a Sphere, "Tsunami", 2009.** As an invited participant in teleconferences and reviewer of scripts, I coaxed the movie's director into giving weight to near-field hazards and to hazard assessments and public education in near-field settings.

<http://www.nnvl.noaa.gov/MediaDetail.php?MediaID=361&MediaTypeID=2>

**Reviews of journal manuscripts.** I decline two-thirds of those requested. Journals for which I provided reviews in recent years:

- 2014 Geological Society of America Bulletin, Marine Geology, Bulletin of the Seismological Society of America, Seismological Research Letters, Eos, Quaternary International, Geology
- 2013 Canadian Journal of Earth Sciences, Geology (2), Geophysical Research Letters
- 2012 Quaternary Research, Journal of Geology and Mining Research, Earthquake Spectra, Natural Hazards and Earth System Science
- 2011 Journal of Geophysical Research, Journal of South American Earth Sciences, Natural Hazards and Earth System Sciences, Proceedings of the National Academy of Sciences, Geophysical Research Letters
- 2010 Journal of Geological Research; Journal of Geophysical Research (2); Pure and Applied Geophysics; Geology; Natural Hazards; Annual Reviews of Marine Science; New Zealand Journal of Geology and Geophysics
- 2009 Natural Hazards; Geology; Journal of Geophysical Research; Bulletin of the Seismological Society of America
- 2008 Notes and Records of the Royal Society; Marine Geology; Science; Journal of Geophysical Research
- 2007 Journal of Earth System Science; Journal of Geophysical Research (2); Earth, Planets and Space
- 2006 Eos; Geophysical Research Letters; G-cubed

**Reviewer of government reports.** In 2012: Washington Division of Emergency Management media guidebook for tsunamis; Cascadia section of Uniform California Earthquake Rupture Forecast version 3; a 400-page book on historical ecology of the Sacramento – San Joaquin Delta, prepared by the San Francisco Estuary Institute for California Department of Fish and Game

**Reviewer of proposals.** Mainly NSF, average two per year in the last decade

**Book editor, 2004.** I played small roles as a junior editor of "The Quaternary Period in the United States," in addition to contributing a chapter (publication 48).

**Associate editor, *Quaternary Research* (1994-2001).** Mainly for citizenship at University of Washington, which owns the journal and does not charge the USGS for office space that its UW-based scientists use. For 30 manuscripts per year on average, selected

reviewers; accepted and rejected articles, requested revisions, edited for content and style. For two months in 2000 served as acting editor-in-chief, a half-time job.

**Peer-review panel.** Member in 1982, 1984, 2003, and 2013. Chair in 1993 and 2004.

**Chief Geologist's Science Advisory Committee,** 1990-1993

**Consultant to Department of Energy** regarding disposal of radioactive waste at Hanford Nuclear Reservation, 1985 (2 days) and 1989 (2 weeks).

(d) LECTURESHIPS AND OTHER ACADEMIC SERVICE

**IRIS/SSA Lecturer**, 2007. Gave invited talks on Cascadia at colleges and universities in Oregon, Nova Scotia, Michigan, Illinois, Alabama, and Indiana, and at a museum in California (section 15). Signed dozens of copies of publication 52, a USGS product that bookstores and student groups obtained through University of Washington Press.

**Tenure evaluator**. Simon Fraser University, 1999; University of Maine, 2000; University of Pennsylvania, 2007; University of Massachusetts and North Carolina State University, 2014.

**Faculty search**. Search committee member, University of Washington School of Oceanography, position in subduction-zone studies, 2013.

**Postdoc adviser**

Subduction-zone paleoseismology in the Japan, Thailand, and the United States—Yuki Sawai, Japan Society for the Promotion of Science, 2006-2008. Main products: a Thai paper to which Sawai and I contributed (publication 56) and a JGR paper on Hokkaido by Sawai.

Hydrology and ecology of sage ponds as recorders of prehistoric earthquakes—Jonathan Hughes, USGS Mendenhall Fellow, supervised jointly with Brian Sherrod, 2003-2006 (<http://geology.usgs.gov/postdoc/profiles/hughes/index.html>). Focus fault-dammed Price Lake, southeast Olympic Mountains, Washington.

**Dissertation adviser**

Storm and tsunami geology of southwest Puerto Rico (subject), Zamara Fuentes, University of Puerto Rico Mayagüez, begun 2010—I did field work with Zamara in southwest Puerto Rico in 2010, and I arranged for her to join surveys of the 2010 tsunami in Chile and of 2010 Hurricane Earl in the British Virgin Islands.

Land-level changes in the last 500 years at Puget Sound (subject), Carolyn Garrison-Laney, University of Washington—Enrolled 2001-2005, on child-rearing leave 2006-2010, resumed 2011 and still making progress in 2015.

“Coastal marsh stratigraphy as an indicator of past earthquakes, Puget Lowland, Washington State,” Maria Elizabeth Martin, University of Washington, defended 2010— One of the dissertation chapters forms the basis of an article in press in *Sedimentology* that reinterprets a sand sheet near Belfair, Washington, as a product of liquefaction, not as a tsunami deposit. I arranged for Martin to join Thai field work that led to her being a coauthor of publication 56.

“The historical ecogeomorphology of Puget Sound lowland rivers,” Brian Collins, University of Washington, defended 2010—Collins remains at University of Washington on a soft-money position. Having examined his dissertation helps me with my current advisory work on ecosystems of the Sacramento – San Joaquin Delta (section 11a).

“Distal records of sandy Holocene lahars from Mount Rainier, Washington”—Paul Zehfuss, University of Washington, completed 2005. I co-chaired the committee with Jim Vallance of Cascade Volcano Observatory. No outside publication other than a Geological Society of America field guide. Zehfuss now works for Shannon & Wilson.

“Pollen records of tidal-marsh subsidence from the 1700 Cascadia earthquake at Tofino, British Columbia,” Jonathan F. Hughes, Simon Fraser University, completed 2002—Led to two journal articles by Hughes, who now teaches in Canada at University of the Fraser Valley.

“Combined use of clast-size measurements and wave-tank experiments to estimate Pleistocene tsunami size,” Andrew L. Moore, University of Washington, completed 1999—Moore now teaches at Earlham College.



(e) TECHNICAL TRAINING PROVIDED

In addition to USAID and Fulbright work (section 11a) and academic service (section 14d):

**Austral Summer Institute XI**, January 2011. One day of lectures in Chile, on earthquake and tsunami geology, for 20 university students and professionals from Chile, Colombia, Ecuador, Perú, Venezuela, and Trinidad. Training hosted by Universidad de Concepción, sponsored in part by UNESCO and Fulbright ([http://www2.udec.cl/oceanoudec/oceanografia/eng/descripcion\\_eng.htm](http://www2.udec.cl/oceanoudec/oceanografia/eng/descripcion_eng.htm)).

**Makran**, 2008 to present. The Makran subduction zone, which extends 800 km along the northwest Indian Ocean margin, poses ill-defined hazards to Oman, Iran, Pakistan, and India. A great Makran earthquake in 1945, on part of the zone's western (Pakistani) half, figured in early debate about Cascadia's seismic potential and produced the Indian Ocean's most deadly tsunami up to 2004. The hazard potential of the zone's western (Omani and Iranian) half is unknown, as is precedent for full-length rupture and for Makran tsunamis that leak into the Persian Gulf. Makran was accordingly identified as a priority for paleoseismic study by UNESCO's working group on assessing Indian Ocean tsunami risk. My main roles: *Co-led workshop*, 10 days of field work and planning in Oman in May 2008 with participants from Australia, Canada, Chile, India, Indonesia, Iran, Oman, Pakistan, Thailand, United States, and Yemen. *Wrote project proposal*, \$250k, two-years, "Assessment and awareness of Makran tsunami hazards" (<http://www.unescap.org/pmd/tsunami/documents/tsunami/TTF-11.pdf>). *Co-led project's Pakistani half* after helping convince UNESCO to shift the field venue from Pakistan to Aceh. The Aceh training, July 10-18, 2011, served 10 Pakistani participants. Hosted one of these participants, a hydrodynamicist interested in tsunami modeling, at University of Washington for 5 weeks in February and March, 2012. Helped prepare UNESCO proposal for follow-up work centered in Pakistan; it is among the finalists culled from 64 submittals to the United Nations Economic and Social Commission for Asia and the Pacific.

**Indian Ocean training in Chile**, February 2005. Two trainees each, recruited on short notice from India and Indonesia. Both Indian scientists remain active today in paleotsunami studies. The two Indonesians do not, but they helped me identify trainees for the USAID project of 2006-2007. All assisted in field work on predecessors to the giant 1960 Chilean and joined as junior authors in a related paper (53). In addition, all served the host country by making presentations at three public workshops (section 15), which themselves formed part of the training. Airfares provided through Rich Calnan, Bill Ellsworth, and Craig Weaver.

(f) SPECIAL ASSIGNMENTS

Through competitive proposals:

**Fulbright Senior Researcher, Indonesia**, 2009-2011, 7 months total; final 2 months planned for 2012—Sections 11a and 12a (publication 57)

**Visiting researcher, Japan**, 1998-1999, 10 months in all—Visiting professor, Earthquake Research Institute, University of Tokyo, and guest researcher, Geological Survey of Japan, Tsukuba. Main objective: field and library work on Japanese written records of the 1700 Cascadia tsunami – work that led, six years and four follow-up visits later, to publication 52. In addition, obtained eyewitness accounts and photographs for USGS tsunami booklets (40, 42), initiated Cascadia publications 46 and 50, and laid groundwork for Japanese papers 45, 47, and 49.

**Gilbert fellowship, Chile**, 1988-1989, 4 months—Geological records and eyewitness accounts of the 1960 Chile earthquake and tsunami (28, 40, 42, 53; also in 33, 52). I led a joint effort with Alan Nelson and Susan Bartsch-Winkler that attracted external NEHRP participation by Joanne Bourgeois.

(15) TECHNOLOGY AND INFORMATION TRANSFER AND DISSEMINATION

The outreach below has probably boosted public understanding of earthquake and tsunami hazards, particularly in the Cascadia region, as judged from the quantity, variety, and persistence of the outreach; from requests to provide the talks, field trips, and interviews; from reprintings of general-interest publications 40, 42, and 52; and from precautions such as building-code revisions and tsunami-evacuation maps.

**Public talks and field trips.** By invitation, since 2004 Indian Ocean tsunami:

2005

January 20, 21	San Juan Nature Institute, Friday Harbor and Lopez Island, WA
February, 3 days	Intendencia (~state) of Chilean Región X (Los Lagos); Municipality of Maullín; rural Chuyaquén; total of three venues in Chile, jointly with scientists from Chile, Indonesia, and India
March 22	Earthquake Engineering Research Institute public briefing, Seattle
March 30	Pacific County tsunami workshop, Tokeland, WA
April 4	Jefferson County tsunami workshops, Port Ludlow and Port Townsend, WA
April 14	American Public Works Association, Tacoma, WA
April 17	Stroum Jewish Community Center, Mercer Is., WA
April 30	Pacific Science Center, Seattle, WA
May 13	House Office Building, Washington, D.C. (arranged by USGS)
May 17	Virginia Mason Hospital Board of Directors, Seattle (the board was considering seismic upgrades)
May 28	Juan de Fuca Festival, Port Angeles, WA
June 2	Washington tribal workshop, Ocean Shores, WA
June 16	Pacific County tsunami workshops, South Bend and Seaview, WA
June 27	University House, Seattle, WA (seniors)
June 30	USGS public lecture, Menlo Park, CA

- October 20 American Museum of Natural History, New York City  
<http://www.amnh.org/education/pd/fall05.html>
- October 26 USGS conference on interdisciplinary science in the Pacific  
Northwest, Troutdale, OR (keynote)
- November 4 NASA Goddard Space Center, Greenbelt, MD
- November 10 International District Rotary Club, Seattle, WA
- November 12 Northwest Paleontological Association, Port Townsend, WA
- December 1 University Bookstore, Seattle, WA (first of several book talks on  
publication 52, arranged by University of Washington Press)
- December 15 Third Place Books, Bothell, WA (arranged by Univ of Wash Press)
- 2006
- January 10 Asian Institute of Technology, Pathumthani, Thailand
- January 12 Chulalongkorn University, Bangkok, Thailand
- February 14 Municipality of Ancud, Chile (panel discussion with USAID-  
supported visitors from Indonesia, Sri Lanka, and Thailand)
- February 27 Burke Museum docents, Seattle, WA
- February 28 Elliott Bay Books, Seattle, WA (arranged by Univ of Wash Press)
- March 3 Central Washington University, Ellensburg, WA
- March 5 Beachcomber's Festival, Ocean Shores, WA
- March 7 Academy for Lifelong Learning (seniors), Bellingham, WA
- March 12 Wahkiakum County Historical Society, Skamokawa, WA
- March 21 Shoreline Rotary, Shoreline, WA
- April 4-5 Grays Harbor County, seven tsunami workshops among Hoquiam,  
Ocean Shores, and Westport, WA
- April 24 University of Portland, OR
- April 24 Powells Bookstore, Portland, OR (arranged by Univ of Wash Press)
- April 28 University of Washington alumni, Seattle, WA
- June 7 Pacific County, two tsunami workshops in Seaview, WA
- June 14 Washington State Real Estate Services and Developers' Council June  
Conference, Tumwater, WA
- June 15 Alliance for Response (librarians and museum curators from the  
Pacific Northwest), Seattle, WA
- July 25 NSF/NOAA tsunami-research workshop, Corvallis, OR
- August 3 EarthScope middle-school educators' workshop, Portland, OR
- September 21 Discovery Park docents, Seattle, WA
- December 14 Vanagiri, Tamil Nadu, India (with scientists from India, Chile,  
Indonesia, and Thailand; USAID project)
- December 21 Kiwanis, Kirkland, WA
- 2007
- January 27 IRIS/SSA, Coos Bay, OR
- March 15 and 16 IRIS/SSA, Halifax, Nova Scotia
- March 18 National Park Service series, Fort Clatsop, OR
- May 17 USGS Woods Hole, MA
- June 5 Seattle Central Community College
- July 18 UNESCO Makran workshop, Bandung, Indonesia
- July 26 Field trip to Willapa Bay for Tsunami Institute
- August 22 Field trip for secondary school teachers, Copalis River, WA

September 4	IRIS/SSA, Aquarium of the Pacific, Long Beach, CA
September 19	Probus of Greater Everett, WA
September 29	Tsunami-geology workshop, Colombo, Sri Lanka
October 3	Indian Institute of Science, Bangalore
October 5	UNESCO/IOC tsunami workshop, Dubai
October 17	IRIS/SSA Grand Valley State Univ., Allendale, MI
October 18	University of Illinois Chicago
October 19	IRIS/SSA Northwestern University, Evanston
October 23	IRIS/SSA Univ. of Alabama, Tuscaloosa, AL
October 24	IRIS/SSA Waubensee Community College, Sugar Grove, IL
November 7	Portland State University, OR
November 7	Geological Society of the Oregon Country, Portland, OR
November 14	IRIS/SSA Earlham College, Richmond, IN
2008	
January 3	Applied Physics Lab, Univ of Washington, Seattle, WA
January 10	Earth and Space Sciences, Univ of Washington
January 11	Beach Watchers, Anacortes, WA
February 21	Washington Division of Emergency Management, local tsunami workshop, Ocosta, WA
March 12 and 27	Briefing and debriefing for British Virgin Island gov't officials
April 16-17	Field trip and talk, state-federal tsunami workshop, Copalis and Ocean Shores, WA
April 26	Field trip for National Earthquake Conference, Johns River, WA
May 1-3	Field trip for Ice-age Floods Institute, Grand Coulee Dam, WA
May 7	Cannon Beach, OR
June 4	State Emergency Managers, national meeting, Post Falls, ID
June 7	Field trip to Willapa Bay with children's book writer
July 7	Planning trip for Teachers on the Leading Edge, Astoria, OR
July 29	Field trip for Teachers on the Leading Edge, Astoria, OR (publication 54)
August 6 and 7	History Channel documentary, Ocean Shores and Copalis, WA
September 15	Field trip for county emergency managers, Copalis, OR
October 23	Field trip for tribal hydrologist, Lummi Reservation, WA
October 29	Press conference, Indian Ocean tsunami recurrence, Portland, OR
November 8-15	Lectures for AusAID project, Indonesia, in Bandung, Makassar [Sulawesi], and Yogyakarta
November 24-26	International Geological Correlation Program, Bangkok, Thailand
December 4	State and local tsunami workgroup, Camp Murray, WA
2009	
January 5	Scripps Institution of Oceanography, La Jolla, CA
January 28	Lummi Island community meeting (near Bellingham, WA)
January 29	North Bend High School, WA
March 4	Debriefing for British Virgin Islands government officials
March 6	University of Puerto Rico, Mayagüez
June 2	Norwegian-Indonesian tsunami workshop, Bandung
July 28	Field trip for Teachers on the Leading Edge, Copalis, WA
July 29	Field trip for North Shore Kayak Club, Copalis, WA

August 5-8	Documentary with NHK, Seattle and Pacific coast, WA
August 21	Field trip for teachers on Tulalip Indian Reservation, WA
August 22	Field trip for Friends of Willapa Bay, near Ilwaco, WA
September 24	International Atomic Energy Agency, Vienna
October 13	Wenatchee Erratics chapter, Ice-Age Floods Institute, WA
October 20	Oregon Museum of Science and Industry "SciencePub", Portland, OR (cosponsored by Geological Society of America, as outreach from its national meeting)
October 27	McMaster University, Hamilton, Ontario
November 2	Puget Sound chapter, Ice-Age Floods Institute, WA
December 3	Stanford University
2010	
January 13	University of the Fraser Valley, Abbotsford, BC
January 23	Active Fault and Earthquake Research Center, Tsukuba, Japan
April 27	Osher Lifelong Learning Institute, Seattle, WA (retirees)
April 28	Rotary Club, Lake Forest Park, WA
May 22	Municipal theater, Maullín, Chile (participants in a field trip that I co-lead served on a panel that fielded questions from a public audience on occasion of the 50th anniversary of the 1960 earthquake)
May 23	Municipal theater, Ancud, Chile (as in Maullín)
June 14	Emergency officials, Majene, Sulawesi, Indonesia
September 20	State Dam Officials, national conference, Seattle, WA (one of three keynote speakers)
October 5	Pacific Science Center "PubScience", Seattle, WA
October 13	Garfield High School, Seattle, WA (four science classes)
November 8	University House, Seattle, WA (seniors)
November 18	Workshop on applying Cascadia turbidite data to National Seismic Hazard Maps, Corvallis, OR
December 6	State-local tsunami workgroup, Camp Murray, WA (on Indonesian publication 57)
2011	
January 6	Pacific Crest School, middle-school class, Seattle
January 10-14	XI Austral short course on marine hazards, Universidad de Concepción, Chile
February 9	British Virgin Islands, Department of Disaster Management, Road Town, briefing on results of 2011 field work at Anegada, BVI
March 1	Menlo Park workshop on future directions for the USGS Coastal and Marine Geology program
March 6	Beachcombers Fun Fair, Ocean Shores, Washington
March 8	Two tsunami-safety workshops, on behalf of the Washington Division of Emergency Management (DEM), on Indian reservations: Quinault Reservation, La Push; Makah Reservation, Neah Bay
March 10	Washington DEM tsunami-safety workshop for officials of Clallam County, Port Angeles (a half day before the Tohoku tsunami)
March 11	Pacific Northwest Montessori teachers' conference, Seattle
March 23	Washington state-local tsunami working group, Camp Murray

	(briefing on National Research Council tsunami report)
March 24	Washington DEM tsunami-safety workshop for residents of Sequim Peninsula Geological Society, Port Townsend WA
March 27	
April 10	“Paws-on Science” booth at Pacific Science Center, Seattle
April 14	American Association of Geographers, national meeting in Seattle
April 19	Lewis and Clark National Park, canoe field trip for NPS interpretive staff, Astoria OR
May 24	City of Hoquiam, canoe field trip for city manager and police chief, Copalis WA.
May 24	Washington DEM tsunami-safety workshop, Hoquiam
June 13	Olympic National Park, training for summer staff, La Push, WA
June 16	U.S. District Court, continuity of operations training for 25 judges from the Court’s offices in Seattle and Tacoma
July 25	Universitas Gadjah Mada, Yogyakarta, Indonesia
September 24	Booth at preparedness fair, Ocean Park, WA
October 12	Society of Inland Northwest Environmental Scientists, Spokane WA
November 3	Cascades Volcano Observatory, Vancouver WA
November 14	Discussion organizer, National Earthquake Prediction Evaluation Council, Seattle
December 12	Hazards field trip in Seattle videotaped by Geological Society of America education staffer for use in secondary schools
2012	
January 4	Columbia Forum, Astoria, OR (public lecture series)
February 22	Seattle hazards field trip for Daniel Lebel, one of the Directors General of the Geological Survey of Canada
March 7	British Virgin Islands, Department of Disaster Management, Road Town, briefing on results of 2012 field work at Anegada, BVI
March 21	Dissenting view of turbidite evidence, workshop for U.S. National Seismic Hazard Maps, Seattle (pub. 61)
April 11	Partners in Emergency Preparedness, Tacoma (a regional gathering of emergency managers; joint with Joan Gomberg, USGS, Seattle)
April 14	Pacific County Preparedness Fair; provided paleoseismological field trip for 40 residents of coastal southwest Washington
April 24	Port Angeles, WA, public high schools; four hours’ field training in tsunami geology at a tidal wetland, 30 students
April 25	Science-Technology-Engineering-Mathematics career talk for students at Seattle Central Community College
May 16	Keynote talk, Pacific Northwest Border Health Alliance annual conference, Tacoma WA; attendees from U.S. public health agencies of Alaska, Idaho, Oregon, Montana, and Washington, and the Canadian Ministries of Health provinces of Alberta, British Columbia, Yukon, and Saskatchewan
June 17	Field trip for Washington State-Local Tsunami Workgroup, Discovery Bay, WA
September 13	Fulbright lecture on climate change, Universitas Tanjungpura, Pontianak, Kalimantan, Indonesia
September 17	Fulbright lecture on climate change, Universitas Diponegoro, Semarang, Java, Indonesia

September 19	Fulbright lecture on climate change, Universitas Jenderal Soedirman, Puerwokerto, Java, Indonesia
September 24	Fulbright lecture on climate change, Universitas Sriwijaya, Palembang, Sumatra, Indonesia
October 12	Keynote talk, SACNAS National Conference, Seattle
December 8	Pacific County (WA) Marine Resource Council
December 10	Washington State-Local Tsunami Workgroup
2013	
January 10	Ice Age Floods Institute, Ellensburg Chapter
February 5	Institut due Physique du Globe de Paris
February 14	Earthquake Engineering Research Institute, National Meeting, Seattle
March 3	Beachcombers' Fun Fair, Ocean Shores WA
March 4	Field trip for secondary school students, Westport WA
April 3	Briefing for officials of the British Virgin Islands, Tortola BVI
May 4	Northwest Geological Society, annual conference
May 9	Field trip for high school students, Port Angeles WA
August 3	Field trip for coastal residents and Washington State Parks, Copalis Beach WA
August 13	Field trip for Cascadia Earthscope Earthquake and Tsunami Education Program, Salmon River, OR
August 30	Liquefaction workshop, Oregon Department of Geology and Mineral Industries, Portland
September 13	Keynote talk, Association of Engineering Geologists, National Meeting, Seattle
September 18	Public talk for Pierce County (WA) Emergency Management, Sumner
November 18	Ice-age floods institute, Edmonds WA
December 4	South Seattle Community College
2014	
January 24	Peninsula College, Port Angeles WA; Joyce Grange, Joyce WA
February 11	Triad Theater, Yelm WA
March 18	Field trip for middle-school students, South Bend WA
April 1-3	Scouted field-trip sites and networked with Indian tribes on the Olympic Peninsula in a two-person reconnaissance with the head of the for Cascadia Earthscope Earthquake and Tsunami Education Program
April 3	Columbia River Maritime Museum, Astoria OR
April 30	Seattle Central Community College, Seattle WA (career talk)
May 12	Field trip for "Awesome Planet" (FOX; Philippe Cousteau) with a high-school student from Port Angeles WA; Discovery Bay, WA
May 14	Field trip for Dungeness River Management Taskforce; Discovery Bay, WA

May 16	Field trip for students from Port Angeles High School and Brown University; Discovery Bay, WA
May 22	Port Ludlow, WA, community preparedness seminar
June 11	Earthquake Science Center, Menlo Park
July 9	University librarians' "Science Boot Camp West," keynote talk (jointly with visitors from Pakistan)
July 31	Delta Science Program, Sacramento CA
August 12	Field trip for Cascadia Earthscope Earthquake and Tsunami Education Program, Aberdeen WA
September 12	Guest lecture in "Numbers and Reason," an undergraduate statistics course, University of Washington

**Cascadia documentaries.** Several in which I play a major role:

- NHK, “Megaquake”. A four-hour series first aired in Japan in 2010 (to commemorate the Kobe earthquake). English-language version through National Geographic.  
<http://www.nhk.or.jp/megaquake/>
- American Museum of Natural History, “Tsunami science—reducing the risk”  
<http://sciencebulletins.amnh.org/earth/f/tsunamis.20051001/index.php>
- Public Broadcasting Corporation, “Cascadia, the hidden fire”  
<http://www.globalnetproductions.com/products.html>
- British Broadcasting Corporation, “The next megaquake”  
[http://www.bbc.co.uk/sn/tvradio/programmes/horizon/megaquake\\_qa.shtml](http://www.bbc.co.uk/sn/tvradio/programmes/horizon/megaquake_qa.shtml)
- Canadian Broadcasting Corporation, “The quake hunters,” <http://www.films.com/id/10444>

**News features** in early 2005 that highlight geologic evidence for great Cascadia earthquakes and tsunamis. For the first three I took the reporters in the field.

- National Public Radio*, Morning Edition, 4 May 2005, “Unearthing proof of a tsunami in the Pacific Northwest” <http://www.npr.org/templates/story/story.php?storyId=4629401> (reported by Rene Montagne)
- Smithsonian*, “Future shocks,” lead article in March 2005 issue  
<http://www.smithsonianmag.com/issues/2005/march/shocks.php>
- Aberdeen [WA] Daily World*, 8 February 2005, “The unthinkable is not so unthinkable here,” [http://www.thedailyworld.com/articles/2005/02/08/local\\_news/01news.txt](http://www.thedailyworld.com/articles/2005/02/08/local_news/01news.txt)
- Time Magazine*, 17 January 2005, “An American tsunami”  
<http://www.time.com/time/archive/preview/0,10987,1015906,00.html>

**Media inquiries** between December 26, 2004 and January 14, 2005: *Aberdeen Daily World*, AP, *Baltimore Sun*, *BBC Focus Magazine*, *Boston Globe*, *Bottomline Personal*, *Bulletin* (Bend, OR), CBS radio, Channel 12 (Phoenix), *Chinook Observer*, *Fox News*, *Globe and Mail* (Toronto), *Icicle Networks* (radio), *Inside Edition*, *KIRO* (Seattle), *Knight-Ridder*, *KOA* (Denver), *KOMO* (radio, Seattle), *KZOK* (radio, Seattle), *Los Angeles Daily News*, *National Geographic News*, *NBC Dateline*, *New Haven Register*, *New York Times*, *Newsday*, *Newsweek*, *NPR*, *Pacifica Radio*, *Philadelphia Inquirer*, *Seattle Post-Intelligencer*, *Seattle Times*, *Spiegel Magazine* (Germany), *The Columbian* (Vancouver, WA), *The Nation*, *Time*, *USA Today*, *WHYY* (Philadelphia), *Radio Times*, *WILL* (radio, U Illinois), *WJR* (radio, Detroit), *WMAY* (radio, Springfield IL)

**Museum open house and exhibit**

“*Cascadia Quakes—A Tricentennial Exposition*” took place at the University of Washington’s Burke Museum, Seattle, the evening of the 300th anniversary of the 1700 Cascadia earthquake. Washington’s Emergency Management Division presented two Japanese researchers with awards for their roles in dating this earthquake and estimating its size. Scientists from government agencies, universities, and private companies displayed three dozen posters.

“*The Big One: Earthquakes in the Pacific Northwest*”—The tricentennial spurred the Burke to create an earthquake and tsunami exhibit that ran February 28 to September 2, 2002 (<http://www.washington.edu/burkemuseum/earthquakes/exhibit.html>). I contributed tree-ring samples, a sediment peel, and Japanese images, and I served as lead scientific adviser. A traveling version reached nine venues in Washington and Oregon in 2002-2004 (<http://www.washington.edu/burkemuseum/earthquakes/travelling.html>).

### **General-interest publications**

*Tsunami-safety booklets.* USGS Circulars (publications 40 and 42) and a similar, more ambitious effort through UNESCO (publication 57). Details, section 12a.

*Book on detective story of the 1700 Cascadia earthquake and tsunami.* Publication 52 is a colorful USGS professional paper aimed at general audiences and published also by University of Washington Press (UWP). The USGS printing went to libraries, state and county emergency managers, and third-world scientists. The first UWP printing sold out; UWP issued a second printing in 2010 (the authors have waived royalties throughout). A reviewer for a history journal called the book “beautiful and unusual,” “meticulous and comprehensive,” and “highly readable” ([historycooperative.org/journals/ohq/108.2/br\\_9.html](http://historycooperative.org/journals/ohq/108.2/br_9.html)). An EarthScope project purchased a copy for each of 75 participants in a selective program for secondary school teachers and community college instructors of Washington and Oregon (<http://orgs.up.edu/totle/>). The U.S. District Court in Seattle provided a copy to each of the 25 judges at the talk listed above from June 16, 2011. Curriculum materials on a National Park Service website use the book as a text for high-school students (<http://www.nps.gov/mora/forteachers/orphan-tsunami.htm>). See also section 19.

*Publication 34* was an initial attempt to describe, for broad audiences, coastal geological evidence for the occurrence of great Cascadia earthquakes. It originated as a chapter in a USGS Professional Paper but probably reached more people as a separate booklet with an art cover. I arranged for this reprinting and for its distribution to state geology agencies of Washington and Oregon in 1997. The booklet is modeled after one that Peter Ward, Bob Page, Laurie Hodgen, and Jeff Troll prepared about the Loma Prieta earthquake.

*Publication 35* was one of the first fact sheets that Bob Page designed when the USGS was threatened with elimination. The sheet describes building-code changes attributable largely to USGS discoveries about Cascadia earthquakes. It reports that more than \$130 million was spent 1988-1995 for strengthening existing dams, bridges, lifelines, and buildings against earthquakes in Washington and Oregon.

*Public art.* An iron casting 5 m tall, explained at its foot by diagrams inscribed in stone, stands beside Seattle’s Duwamish River at a Port of Seattle park. The casting simulates a sediment peel, 0.5 m wide, that was made during a Japanese demonstration project that I hosted in 2000. The peel’s stratigraphic sequence tells of a Pleistocene glacial lake, a Holocene tidal flat, burial of that flat by lahar runout from Mount Rainier (Zehfuss thesis, section 14d, p. 13), and uplift of the buried tidal flat during the Seattle earthquake of AD 900-930. In 2001 I helped the artist design the casting and prepared the diagrams (which went through peer review and received Director’s Approval).  
<http://www.artistthinker.com/residencies/alki.html>

*Public-domain images.* Authors, publishers, and documentary makers ask me for high-resolution versions of illustrations, particularly those in publication 52. Recent requesters: “Investing in the Early Modern Built Environment: Europeans, Asians, Settlers and Indigenous Societies” (USC, Huntington Early Modern Studies Institute, 2012), *Popular Science* (2010), *Science Illustrated* (2010), “Geology and the Environment” (a college textbook with an initial printing of 16,000, 2010), “Earthquakes: Science and Society” (Prentice-Hall, 2010), “Ghost Mountains and Vanished Oceans: North America from Birth to Middle Age” (Canadian children’s book, 2009), a curriculum unit for secondary-school science (<http://www.scieds.com/cases/unitIII.html>, 2009), “Nature’s Clocks—How Scientists Measure the Age of Almost Everything” (University of California Press, 2008), “Our Amazing Planet” (<http://www.ouramazingplanet.com/1694-cascadia-fault-earthquake-monitors.html>).

### **Public inquiries to the Earthquake Hazard Program**

Provided e-mail response to 6 inquiries in 2007, 5 in 2008, 8 in 2009, 16 in 2010, 29 in 2011, 5 through early May 2012.

### **17. HONORS, AWARDS, RECOGNITION, ELECTED MEMBERSHIPS**

Best paper award, Structure and Tectonics Division, Geological Society of America (2009; for publication 23; [http://rock.geosociety.org/sgt/SGT\\_News\\_Feb2010.pdf](http://rock.geosociety.org/sgt/SGT_News_Feb2010.pdf))

Member, National Academy of Sciences (elected 2007)

USGS Excellence in Leadership Award (2007, for USAID Indian Ocean work; courtesy of Walter Mooney)

Blue Pencil Award, National Association of Government Communicators (2006; for publication 52)

*Time* 100 (2005; for a feel-good U.S.-linked story related to the then-recent Indian Ocean tsunami; <http://www.time.com/time/2005/time100/scientists/>)

Shoemaker Award, U.S. Geological Survey (2000; for publication 40)

Kirk Bryan Award, Quaternary Geology and Geomorphology Division, Geological Society of America (2000; for publication 39)

Fellow, American Geophysical Union (elected 1999)

Affiliate Professor, University of Washington (1985 to present; full-professor affiliation since 1994)

Editor's Citation for Excellence in Refereeing, *Journal of Geophysical Research* (1994)

Fellow, Geological Society of America (elected 1990)

### **(18) BIBLIOGRAPHY**

Percentage contributions to multiple-author publications estimated, where appropriate, for concept and design (*concept*), data production (*data*), analysis and interpretation (*analysis*), and writing and illustrating (*writing*).

1. Atwater, B.F., and Hedel, C.W., 1976, Distribution of seed plants with respect to elevation and water salinity in the northern San Francisco Bay estuary, California: U.S. Geological Survey Open-File Report 76-389, 41 p.  
*80 concept, 50 data, 70 analysis, 90 writing*
2. Atwater, B.F., Hedel, C.W., and Helley, E.J., 1977, Late Quaternary depositional history, Holocene sea-level changes, and vertical crustal movement, southern San Francisco Bay, California: U.S. Geological Survey Professional Paper 1014, 15 p.  
*70 concept, 70 data, 80 analysis, 90 writing*
3. Atwater, B.F., 1978, Central San Mateo County, California, in G. D. Robinson and A. M. Spieker, ed., "Nature to be commanded...": U.S. Geological Survey Professional Paper 950, p. 11-19.
4. McDonald, S.D., Nichols, D.R., Wright, N.L., and Atwater, B.F., 1978, Thickness of young bay mud, southern San Francisco Bay, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-976 (scale 1:125,000).

*20 concept, 10 data, 20 analysis, 50 writing. I completed a map left nearly finished by Nichols and two coworkers.*

5. Atwater, B.F., Conard, S.G., Dowden, J.N., Hedel, C.W., MacDonald, R.L., and Savage, Wayne, 1979, History, landforms, and vegetation of the estuary's tidal marshes, in T.J., Conomos, ed., San Francisco Bay, the urbanized estuary: Pacific Division, American Association for the Advancement of Science, p. 347-386, [http://www.estuaryarchive.org/archive/conomos\\_1979/18/](http://www.estuaryarchive.org/archive/conomos_1979/18/)  
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7. Atwater, B.F., 1979, Generalized geologic map of the Rio Vista 15-minute quadrangle, California: U.S. Geological Survey Open-File Report 79-853, scale 1:62,500.
8. Marchand, D.E., and Atwater, B.F., 1979, Preliminary geologic map showing Quaternary deposits of the Lodi area, California: U.S. Geological Survey Open-File Report 79-933, scale 1:62,500.  
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9. Atwater, B.F., and Belknap, D.F., 1980, Tidal-wetland deposits of the Sacramento - San Joaquin Delta, California, in Field, M. E., Bouma, A. E., and Colburn, Ivan, eds., Quaternary deposition environments of the Pacific Coast: American Association of Petroleum Geologists, p. 89-103.  
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10. Atwater, B.F., 1980, Attempts to correlate late Quaternary climatic records between San Francisco Bay, the Sacramento-San Joaquin Delta, and the Mokelumne River, California: Ph.D. thesis, University of Delaware, Newark, 214 p.
11. Atwater, B.F., and Marchand, D.E., 1980, Preliminary maps showing late Cenozoic deposits of the Bruceville, Elk Grove, Florin, and Galt 7.5-minute quadrangles, Sacramento and San Joaquin Counties, California: U.S. Geological Survey Open-File Report 80-849, scale 1:24,000.  
*60 all*
12. Atwater, B.F., 1980, Distribution of vascular-plant species in six remnants of intertidal wetland of the Sacramento-San Joaquin Delta, California: U.S. Geological Survey Open-File Report 80-883, 46 p.
13. Atwater, B.F., Ross, B.E., and Wehmiller, J.F., 1981, Stratigraphy of Late Quaternary estuarine deposits and amino acid stereochemistry of oyster shells beneath San Francisco Bay, California: *Quaternary Research*, v. 16, p. 181-200.

*80 concept, 40 data, 50 analysis, 90 writing. Summarizes Ross's M.S. thesis, which I informally helped supervise, and amino-acid results that I obtained in Wehmiller's lab and interpreted under his guidance.*

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18. Atwater, B.F., and Rinehart, C.A., compilers, 1984, Preliminary geologic map of the Colville Indian Reservation, Ferry and Okanogan Counties, Washington, with a table of potassium-argon ages compiled by Robert J. Fleck: U.S. Geological Survey Open-File Report 84-389, 17 p., scale 1:100,000.

*Contains contributions from four other mappers and their assistants. I did one-fifth of the mapping and three-fifths of the compilation. Reinhart led the project.*

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*30 concept, 30 data, 50 analysis, 70 writing*

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*70 all*
26. Atwater, B.F., Stuiver, M., and Yamaguchi, D.K., 1991, Radiocarbon test of earthquake magnitude at the Cascadia subduction zone: *Nature*, v. 353, p. 156-158.  
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*I led field party of as many as 20 persons, compiled the illustrations, and wrote the report. The entire effort was prompted by Stephen Obermeier's discovery of liquefaction features along the Columbia River, and by the importance he placed on their size and abundance.*
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- K., Sawai, Y., and Shimokawa, K., 2004, Seventeenth-century uplift in eastern Hokkaido, Japan: *The Holocene*, v. 14, p. 487-501.  
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- school teachers to EarthScope [feature article]: *Eos*, v. 87, p. 257, 261.  
*10 concept, 10 writing. The program received guidance from Ray Wells, Rick Blakeley, and me. I led the field trip highlighted in the article.*
55. Satake, K., and Atwater, B.F., 2007, Long-term perspectives on giant earthquakes and tsunamis at subduction zones: *Annual Review of Earth and Planetary Science*, v. 31, p. 555-577.  
*50 all. An Annual Reviews editor invited a chapter from Satake, who asked my help.*
56. Jankaew, K., Atwater, B.F., Sawai, Y., Choowong, M., Charoentitirat, T., Martin, M.E., and Prendergast, A., 2008, Medieval forewarning of the 2004 Indian Ocean tsunami in Thailand: *Nature*, v. 455, p. 1228-1231, doi:10.1038/nature07373.  
*40 concept, 20 data, 30 analysis, 60 writing. I helped Jankaew, a talented petroleum geochemist, lead the field work (section 19). I did most of the writing, prepared illustrations jointly with Sawai, and supported the submittal further by editing a companion manuscript on similar evidence from West Aceh.*
57. Eko Yulianto, Fauzi Kusmayanto, Nandang Supriyatna, and Mohammad Dirhamsyah (compilers), and Atwater, B.F., Eko Yulianto, and Kodijat, A.M. (adapters), 2010, Where the first wave arrives in minutes—Indonesian lessons on surviving tsunamis near their sources: UNESCO, Intergovernmental Oceanographic Commission, IOC Brochure 2010-4, 28 pp., <http://ioc-tsunami.org/>  
*50 concept, 20 data, 40 analysis, 40 writing. I rewrote most of Yulianto's text and supported it with maps, graphs, references, and footnotes. Yulianto, Kodijat, and I together struggled with nuances of language, culture, and religion, and with reporting on the challenges of providing instrumental warnings of near-field tsunamis.*
58. Atwater, B.F., Barrientos, S., Cifuentes, I., Cisternas, M., and Wang, K., 2010, Observing the greatest earthquakes—AGU Chapman Conference on Giant Earthquakes and Their Tsunamis; Viña del Mar and Valparaíso, Chile, 16-20 May 2010 [meeting report]: *Eos*, v. 91, p. 420.  
*60 writing*
59. Atwater, B.F., ten Brink, U.S., Buckley, M., Halley, R.S., Jaffe, B.E., López-Venegas, A.M., Reinhardt, E.G., Tuttle, M.P., Watt, S., and Wei, Y., 2010, Geomorphic and stratigraphic evidence for an unusual tsunami or storm a few centuries ago at Anegada, British Virgin Islands: *Natural Hazards*, 34 pp. + electronic supplement, doi:10.1007/s11069-010-9622-6  
*80 concept, 30 data, 60 analysis, 90 writing. Main paper of five, all in the same issue. The companion papers give ownership to younger scientists who examined, in 2009, evidence I had found in a 2008 reconnaissance with Tuttle.*
60. Orcutt, J.A., Grabowski, M.R., Atwater, B.F., Bostrom, A., Crawford, G., Eisner, R.K., Lin, J., Luther, D.S., Milburn, H.B., Mileti, D.S., Synolakis, C.E., Wood, N.J., Yeh, H., Mengelt, C., and Park, S., 2011, Tsunami warning and preparedness—An assessment of the U.S. tsunami program and the nation's preparedness efforts: National Research Council, 296 pp. [http://books.nap.edu/catalog.php?record\\_id=12628](http://books.nap.edu/catalog.php?record_id=12628)

*20 concept, 10 data, 10 analysis, 10 writing. In addition to roles recounted in section 14c (p. 11), I provided parts of the chapters on risk assessment and public education, and I helped other committee members review roles of seismology and GPS in tsunami warning.*

61. Atwater, B.F., and Griggs, G.B., 2012, Deep-sea turbidites as guides to Holocene earthquake history at the Cascadia Subduction Zone—Alternative views for a seismic-hazard workshop: U.S. Geological Survey Open-File Report 2012–1043, 58 p., <http://pubs.usgs.gov/of/2012/1043/>

*90 concept, 10 data, 90 analysis, 90 writing.*

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#### PROMOTION TO ST

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62. Atwater, B.F., Cisternas, M., Yulianto, E., Prendergast, A.L., Jankaew, K., Eipert, A.A., Fernando, W.I.S., Tejakusuma, I., Schiappacasse, L., and Sawai, Y., 2013, The 1960 tsunami on beach-ridge plains near Maullín, Chile: Landward descent, renewed breaches, aggraded fans, multiple predecessors: *Andean Geology*, v. 40, p. 393-418, doi:10.5027/andgeoV40n3-a01.

*80 concept, group data, 80 analysis, 90 writing.*

63. Atwater, B.F., Fuentes, Z., Halley, R.B., Ten Brink, U.S., and Tuttle, M.P., 2014, Geologic effects of 2010 Hurricane Earl amidst evidence for greater overwash at Anegada, British Virgin Islands: *Advances in Geosciences*, v. 38, p. 21-30, doi:10.5194/adgeo-38-21-2014.

*50 concept, group data, 50 analysis, 90 writing.*

64. Atwater, B.F., Carson, B., Griggs, G.B., Johnson, H.P., and Salmi, M.S., 2014, Rethinking turbidite paleoseismology along the Cascadia Subduction Zone: *Geology*, v. 42, p. 827-830, doi:10.1130/G35902.1.

*50 concept, 0 data, 70 analysis, 70 writing. The paper relies on data from the 1960s and 1970s that was largely collected by Carson and Griggs.*

65. Kakar, D.M., Naeem, G., Usman, A., Hasan, H., Lodhi, H.A., Srinivasalu, S., Andrade, V., Rajendran, C.P., Naderi Beni, A., Hamzeh, M.A., Hoffmann, G., Al Balushi, N., Gale, N., Kodijat, A.M., Fritz, H.M., and Atwater, B.F., 2014, Elders recall an earlier tsunami on Indian Ocean shores: *Eos (Transactions, American Geophysical Union)*, v. 95, p. 485-486, doi:10.1002/2014EO510002.

*20 concept, 10 data, 10 analysis, 90 writing. Introduces a UNESCO book ([http://iotic.ioc-unesco.org/images/xplod/resources/material/1945%20makran%20tsunami\\_2mb.pdf](http://iotic.ioc-unesco.org/images/xplod/resources/material/1945%20makran%20tsunami_2mb.pdf)) for which I served as the main editor, and to which I also contributed original and archival maps.*

## (19) SIGNIFICANT CONTRIBUTIONS

23. Atwater, B.F., 1987, Evidence for great Holocene earthquakes along the outer coast of Washington State: *Science*, v. 236, p. 942-944.

Geological recognition of Cascadia's great-earthquake history began with publication 23. The paper appeared at a time when the geophysical case for great Cascadia earthquakes lacked, in the words of Canadian seismologist, a "smoking gun." The smoking gun in publication 23 consists of estuarine deposits best explained by coseismic subsidence and attending tsunamis on Washington's Pacific coast. This Washington example prompted other geologists to find such evidence in British Columbia, Oregon, and California. The resulting combination of geophysical and geological evidence helped strengthen building codes and raise tsunami awareness at Cascadia before Japanese history and Canadian GPS erased doubts about the region's great-earthquake potential.

52. Atwater, B.F., Musumi-Rokkaku, S., Satake, K., Tsuji, Y., Ueda, K., and Yamaguchi, D.K., 2005, The orphan tsunami of 1700—Japanese clues to a parent earthquake in North America: U.S. Geological Survey Professional Paper 1707 (published in association with University of Washington Press; reprinted 2010), 133 p., <http://pubs.usgs.gov/pp/pp1707>

Publication 52 recounts a transpacific detective story behind today's consensus that the Cascadia subduction zone produces earthquakes as large as magnitude 9. That consensus underpins increased tsunami preparedness and tougher building standards at Cascadia. Kenji Satake and I conceived of the book as a way to convey the content and context of Japanese writings that helped pinpoint the date and estimate the size of Cascadia's most recent great earthquake. A seven-year collaboration with Kenji and the other authors broadened the book's purpose to include engaging broad audiences in Cascadia earthquake and tsunami science. The book frames its Japanese content with North American paleoecology, sedimentology, paleoliquefaction, archaeology, radiocarbon dating, and dendrochronology, largely from publications 25-27, 33, 35-39, 43, 44, 48, and 50. I prepared most of the text and graphics, negotiated joint publication with University of Washington Press, made the printers' files, and gave bookstore and IRIS/SSA talks that helped get the book into readers' hands. Additional details under "General-interest publications" (section 15).

56. Jankaew, K., Atwater, B.F., Sawai, Y., Choowong, M., Charoentitirat, T., Martin, M.E., and Prendergast, A., 2008, Medieval forewarning of the 2004 Indian Ocean tsunami in Thailand: *Nature*, v. 455, p. 1228-1231, doi:10.1038/nature07373.

Publication 56 presents the first evidence for predecessors to the 2004 Indian Ocean tsunami. I co-lead the field work and led in writing of the paper as part of my efforts to promote geology as grounds for warning, decades in advance, of future earthquakes and tsunamis. The paper's first author, Kruawun Jankaew, is a petroleum geochemist who first encountered tsunami geology among corpses near Phuket. I led a USAID effort that gave her contrasting field experience, first with clear geological records of recurrent tsunamis in Chile (53), second with the difficulty of finding such records in the crab-burrowed soils of Indonesian and Indian mangroves. In Thailand Jankaew and I persisted, eventually finding the beautiful examples of pre-2004 tsunami deposits that publication 56 describes. She went on to receive field support from Germany, a national award from Crown Princess Sirindhorn, and workshop roles in Japan, Philippines, Indonesia, and Iran. Publication 53 similarly helped credential its first author, Marco Cisternas, as a Chilean leader in earthquake and tsunami science, and publication 57 has strengthened the hands of its Indonesian principals.

(20) POSITION DESCRIPTION Geologist, ST-1350, Brian F. Atwater

## INTRODUCTION

The incumbent is an international leader in studying geologic history from recent millennia to identify hazards from earthquakes and tsunamis at subduction zones. The work includes communicating the findings to officials, engineers, and the public, in hopes of reducing future losses of life and livelihood. Most of the research takes place in coastal regions where tectonic plates converge. Though anchored in the northwestern United States the work extends to comparable efforts overseas, both to improve understanding of domestic earthquake hazards and to strengthen USGS roles internationally. The international venues include the Caribbean, Chile, Japan, and South and Southeast Asia. The incumbent increasingly serves as an adviser and mentor. The advisory roles include service on a scientific panel that grapples with environmental issues related to water use and endangered fish in California. The position is in the Earthquake Science Center, Menlo Park, California, and the incumbent is based in Seattle at the University of Washington.

## I. RESEARCH ASSIGNMENT

The incumbent plays leading roles nationally and internationally in using coastal geology to help identify and address hazards from earthquakes and tsunamis. At the Cascadia subduction zone, the incumbent serves as a senior spokesperson, mentors other scientists, and continues to develop findings that clarify earthquake history and influence hazard assessment. In the Caribbean, the incumbent leads studies that distinguish geologically between hurricanes and tsunamis, and which address the longstanding mystery of whether great earthquakes happen along the Puerto Rico Trench. In Asia, the incumbent completes Fulbright research in Indonesia and assists UNESCO with hazard assessment and hazard awareness at the Makran subduction zone, budgets and security conditions permitting. In Chile the incumbent serves as mentor and adviser. The research assignment also includes service as a charter member of the Delta Independent Science Board, a ten-person panel mandated by the California legislature to oversee science programs and to review scientific issues at a hub of state-wide controversies over water diversions and ecosystem health.

## II. SUPERVISORY CONTROLS

The incumbent functions independently. He has complete responsibility for defining his research directions and outreach efforts. For guidance on earthquake and tsunami work he consults with the Earthquake Science Center Director and with other colleagues and managers both within and outside the USGS. He vets his research findings through rigorous peer review, after which the scientific conclusions and interpretations are considered technically sound. Because the Delta Independent Science Board mandate includes review of USGS science, the incumbent avoids potential conflicts of interest by staying at arm's length from USGS studies that may pertain to any issues before the Board.

### III. GUIDELINES AND ORIGINALITY

There are few if any guidelines for incumbent's mix of research, outreach, and advisory service. The incumbent uses conventional methods in estuarine stratigraphy and paleoecology but has applied them unconventionally in assessing earthquake and tsunami hazards. The incumbent uses ordinary geology to extraordinary effect by making scientific breakthroughs that influence programmatic directions and societal responses in the field of earthquake and tsunami hazards.

The incumbent draws on decades of practice in speaking, writing, and illustrating to help communicate the findings to broad audiences. The international work entails facility with foreign language and sensitivity to cultures and religions. The Delta Independent Science Board lacks precedent in working under legislation, from 2009, that treats ecosystem health as "co-equal" with water exports as California state policy.

### IV. CONTRIBUTIONS, IMPACT, AND STATURE

The incumbent applies field geology to fundamental questions about earthquake and tsunami hazards. He draws on backgrounds in geologic mapping, in the Quaternary geology of estuaries, lakes, and streams, and in earthquake and tsunami geology internationally. Evidence of his stature includes election as a member of the National Academy of Sciences and as a fellow of both the Geological Society of America and the American Geophysical Union.

The incumbent has more than three decades' experience as a writer, illustrator, and editor. His initial paper on the Cascadia subduction zone, published in 1987, received the best paper award from the Structure and Tectonics Division of the Geological Society of America in 2009. A subsequent monograph on earthquake recurrence, in 1996, received the best paper award from GSA's Quaternary Geology and Geomorphology Division in 2000. The incumbent's early reports and maps about the geology and botany of the Sacramento – San Joaquin Delta have become standard references. He is also known for documenting the most complete of the known records of the dozens of floods that issued from an ice-age lake in Montana.

The incumbent's output also includes widely used publications and abundant talks for broad audiences. He led in preparing a USGS tsunami-safety booklet that is based mainly on eyewitness accounts in Chile, and a USGS monograph about Japanese accounts of an AD 1700 tsunami from the Cascadia subduction zone. Also he led in adapting an Indonesian tsunami-safety booklet for international use through UNESCO. The incumbent's speaking engagements, nearly all by invitation, average at least one monthly. They include talks for high-school and university students, science teachers, public-health officials, engineers, and emergency managers.

The incumbent increasingly serves as a reviewer and mentor. He led in expanding the scope of a review of the nation's tsunami program by the National Research Council, and he served

on the review committee. He advises Ph.D. candidates at University of Washington and University of Puerto Rico. Much of his Fulbright work in Indonesia has involved mentoring of professional scientists in government agencies. Scientists he mentored previously in Chile and Thailand have emerged as leaders in tsunami geology. Through UNESCO he has co-lead two capacity-building projects on Indian Ocean tsunami geology and preparedness.

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