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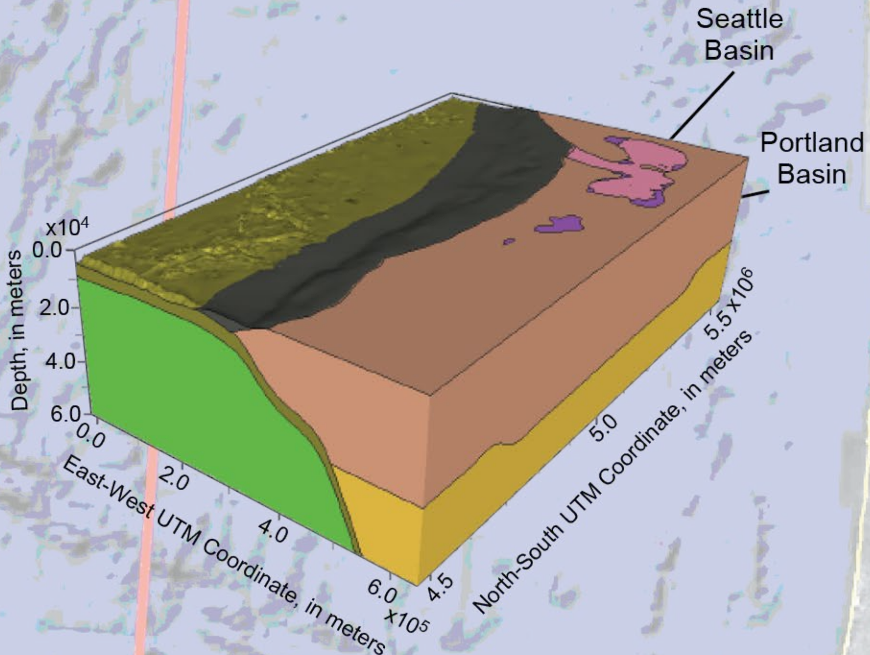
Earthquake Hazards Ground Motion Investigations

P- and S-wave Velocity Models Incorporating the Cascadia Subduction Zone for 3D Earthquake Ground Motion Simulations, Version 1.6—Update for Open-File Report 2007–1348



Open-File Report 2017–1152
Version 1.1, September 2019
Supersedes USGS Open-File Report 2007–1348

U.S. Department of the Interior
U.S. Geological Survey

Cover. Base image is from figure 1, this report, and is the region of velocity models described in this report. Geologic model volume including the Cascadia subduction zone is from figure 3, this report.

P- and S-wave Velocity Models Incorporating the Cascadia Subduction Zone for 3D Earthquake Ground Motion Simulations, Version 1.6—Update for Open-File Report 2007–1348

By William J. Stephenson, Nadine G. Reitman, and Stephen J. Angster

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U.S. Department of the Interior
RYAN K. ZINKE, Secretary

U.S. Geological Survey
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Acknowledgments

The V_P and V_S property volumes of model V1.6 were greatly improved by feedback from end-users including Art Frankel (U.S. Geological Survey [USGS]), Andy Delorey (Los Alamos National Laboratory), and John Vidale (University of Washington). We thank Jack Odum and Robert Williams (USGS) for their technical reviews, which greatly improved this manuscript. Special thanks to Jordan Bretthauer (USGS) for assistance in developing figure 1 of this report. Discussions with numerous collaborators and other interested parties seeking components of the model for their research helped prompt us to formally complete this updated documentation. This research was supported by funding from the USGS Earthquake Hazards Program.

Contents

Figures

Conversion Factors

International System of Units to U.S. customary units

Multiply	By	To obtain
	Length	
centimeter (cm)	0.3937	inch (in.)
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
	Density	
gram per cubic centimeter (g/cm^3)	62.4220	pound per cubic foot (lb/ft^3)

P- and S-wave Velocity Models Incorporating the Cascadia Subduction Zone for 3D Earthquake Ground Motion Simulations—Update for Open-File Report 2007–1348

Version 1.6

By William J. Stephenson,[1] Nadine G. Reitman,[2] and Stephen J. Angster[3]

Introduction

In support of earthquake hazards studies and ground motion simulations in the Pacific Northwest, three-dimensional (3D) P- and S-wave velocity (V_P and V_S, respectively) models incorporating the Cascadia subduction zone were previously developed for the region encompassed from about 40.2°N. to 50°N. latitude, and from about 122°W. to 129°W. longitude (fig. 1). This report describes updates to the Cascadia velocity property volumes of model version 1.3 ([V1.3]; Stephenson, 2007), herein called model version 1.6 (V1.6). As in model V1.3, the updated V1.6 model volume includes depths from 0 kilometers (km) (mean sea level) to 60 km, and it is intended to be a reference for researchers who have used, or are planning to use, this model in their earth science investigations. To this end, it is intended that the V_P and V_S property volumes of model V1.6 will be considered a template for a community velocity model of the Cascadia region as additional results become available. With the recent and ongoing development of the National Crustal Model (NCM; Boyd and Shah, 2016), we envision any future versions of this model will be directly integrated with that effort.

Background

The Cascadia subduction zone stretches for over 1,000 km, from the Mendocino Triple Junction off the northern California coast northward to Vancouver Island, Canada (fig. 2). The primary reasons for developing these model volumes are (1) for simulating strong earthquake ground motions in the urbanized sedimentary basins of western Washington and Oregon, and (2) for simulating tsunami effects from a great (moment magnitude [**M**] 8–9) Cascadia subduction zone earthquake. As such, these are geophysical property models constrained by first-order geologic boundaries only. We do not attempt to explicitly represent detailed geologic terranes in the model volume unless they were deemed important for ground motion variability in urbanized regions. Thus, unique terranes within the continental crust, such as Siletz (see Trehu and others, 1994) or Wrangellia (Jones and others, 1977) are not treated as unique units within the model; however, their effects on ground motions are essentially represented through the use of passive- and active-source tomographic imaging results. Similarly, serpentinized mantle (for example, Bostock and others, 2002) is not explicitly included, but its existence can be partially inferred from the V_S and V_P property data.

The P- and S-velocity volumes of model V1.6 were developed with EarthVision software, version. 9.0, on the Linux operating system. Matlab version R2015b was used for carrying out quality-control of the model volumes output in Institute of Electrical and Electronics Engineers, Incorporated (IEEE) binary format from EarthVision. While a wealth of published information for the Cascadia region has been incorporated in the development of these models, significant smoothing during extrapolation and interpolation in portions of the model were required to create the model interfaces and geophysical property volumes. Because there are many areas within the model where published data are sparse or of low resolution, there is very likely significant uncertainty and therefore subjectivity involved in building model horizons and in populating the model volumes.

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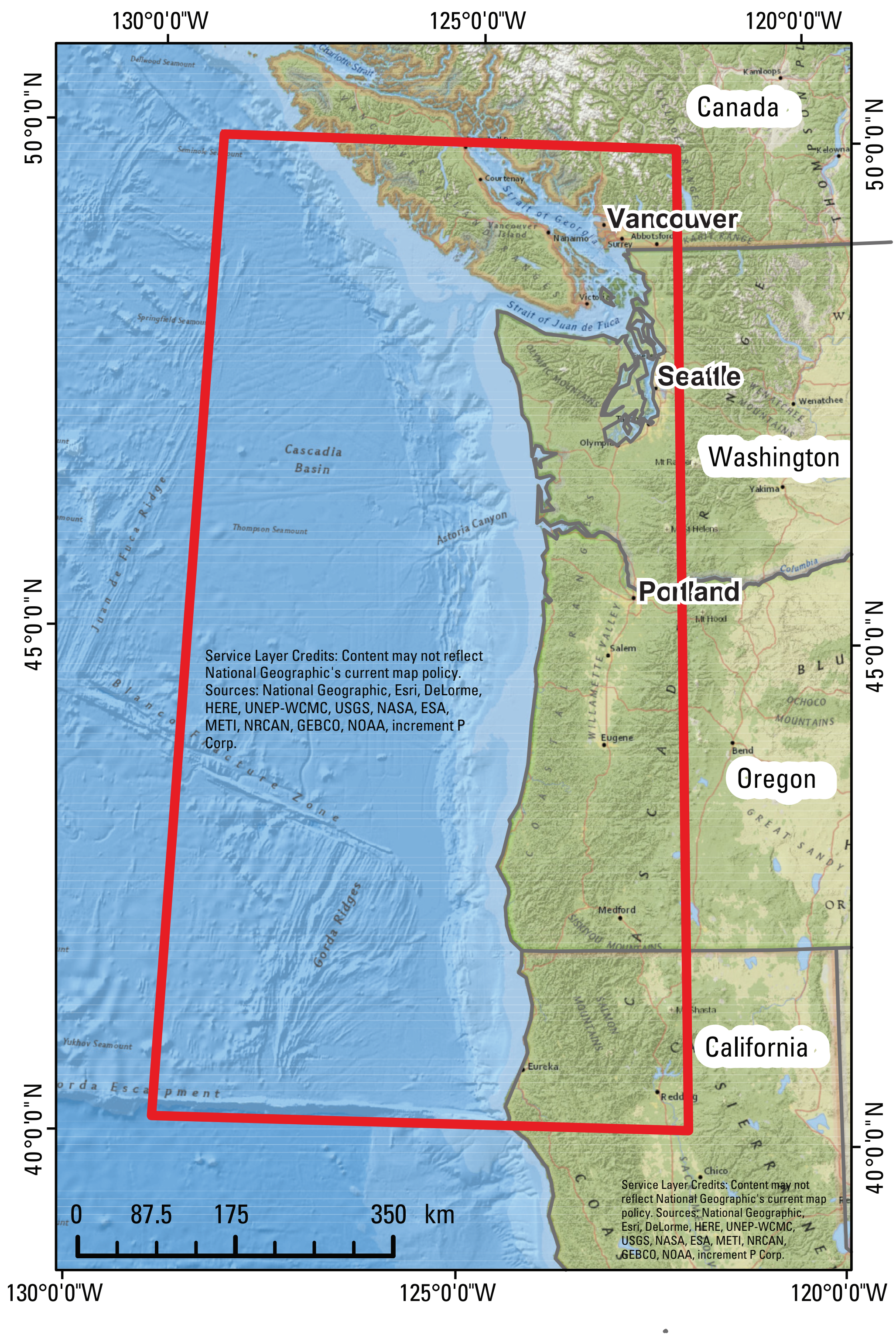

Figure 1. Region of velocity models described in this report. Base map shows the urban centers of Portland, Oreg., Seattle, Wash., and Vancouver, British Columbia. Red polygon is approximate boundary of velocity property volumes that include the Cascadia subduction zone. Latitude and longitude coordinates at corners of red polygon are, clockwise from upper left, 50°N., 129°W.; 50°N., 122°W.; 40.2°N., 122°W.; and 40.2°N., 129°W. Projection is World Geodetic System 1984 (WGS 84) datum.

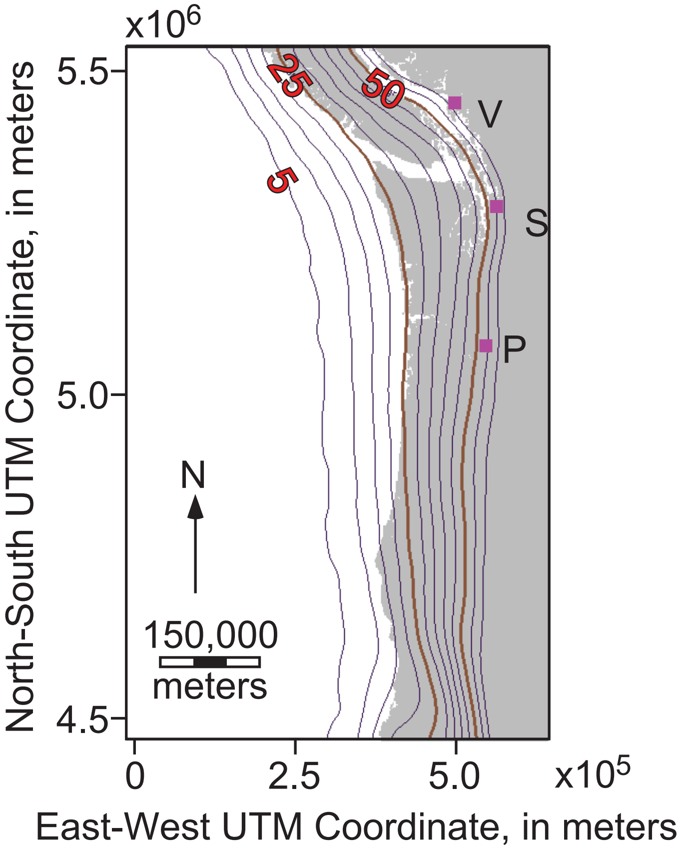

Figure 2. Contour map of Cascadia subducting slab upper surface in model region (McCrory and others, 2012; Blair and others, 2013). Contours are from 5 km to 60 km depth, in kilometers below mean sea-level. Gray region is continental North America, with the cities of Vancouver, British Columbia (V), Seattle, Wash. (S), and Portland, Oreg. (P), shown. UTM, Universal Transverse Mercator.

The model volume incorporates bathymetry but does not incorporate topography. Topography is not included in model V1.6 because the objective in developing these models was for use in 3D finite-difference ground motion calculations with modeling codes that do not allow grid points for terrain. However, topography will be included in any future update of this model, likely as part of the NCM, to accommodate advances in ground motion simulations. Finally, there has been limited research into adding a geotechnical velocity gradient to approximate weathering in the shallow crust (for example, Shaw and others, 2015) and adding randomness to the velocity property values. These additional parametrizations show promise for improving ground motion simulations, but have not been included in model V1.6.

Investigations Using Model V1.3

The first released version of model V1.3 found important use in the seismological and physics communities. A non-comprehensive list of published investigations using all or part of model V1.3 includes: (1) Frankel and Stephenson (2000) and Stephenson and Frankel (2003), who used subregions of V1.3 for ground motion simulations valid up to 0.1 hertz (Hz); (2) Frankel and others (2007) used a larger subregion of model V1.3 that included the structural and geophysical detail in the southern Puget Lowland for scenario earthquake simulations, including 3D basin effects in the Seattle basin, that were incorporated into the Seattle Urban Seismic Hazard Maps; (3) Olsen and others (2008) used the entire model volume to carry out a deterministic Cascadia simulation up to 0.5 Hz using a Sumatra-Andaman Islands rupture scenario; (4) Delorey and Vidale (2011) used the model for comparison with V_S derived from ambient noise tomography in the Seattle basin; (5) Molnar and others (2014) used the northern half of the model as a starting point for ground motion modeling and seismic hazards investigations in the Vancouver, British Columbia region; and (6) Wagner and others (2012) used the model in a theoretical physics experiment to test the weak equivalence principle.

Primary Differences Between Models V1.3 and V1.6

Several important modifications were done in the development of model V1.6. First, density (rho) values for all V1.6 model units are not provided as a separate property volume as was done for model V1.3. Instead, end-users will need to estimate the rho parameters for their specific purpose. Lacking an alternative approach, we still recommend calculation of rho directly from P-wave velocity (V_P) using the empirical relationship of Brocher (2005), which is approximately the deterministic form of the Nafe-Drake law. This empirical equation is:

$$\text{rho} = 1.6612 * V_P - 0.4721 * V_P^2 + 0.0671 * V_P^3 - 0.0043 * V_P^4 + 0.000106 * V_P^5$$

where V_P is in kilometers per second (km/s) and rho is density in grams per cubic centimeter) (g/cm^3). After this calculation, we recommend the minimum and maximum non-water densities be constrained to 2.0 and 3.5 g/cm^3, respectively, and ocean water be set to 1.028 g/cm^3.

Within the model volume, several notable changes to geologic structure and property parameter datasets were made: (1) the surficial contact between Quaternary and Tertiary sediments in western Washington State was redefined at higher resolution using the geologic map of Schuster (2005); (2) V_S for the continental crust and mantle were modified to use the tomographic results of Moschetti and others (2007), with V_P in these units now calculated from empirical relationships of Brocher (2005) at locations distal to the Puget Lowland; (3) bathymetry was updated to use the General Bathymetric Chart of the Oceans 2014 (GEBCO_2014) gridded data (GEBCO, 2015); (4) the surface geometry of the subducting slab was updated with the data of McCrory and others (2012) and Blair and others (2013); (5) the base of the subducting oceanic crust was redefined from downward projection of a smoothed version of the data of McCrory and others (2012) and Blair and others (2013).

The Primary Geology-Based Model Units and Their Velocity Properties

The following section is from Stephenson (2007). The backbone of the velocity property volumes is the geologic model, consisting of autonomous units representing simplified geologic units. Six primary units were defined for this model. As shown in figure 3, these are: (1) continental sedimentary basins (subdivided into Quaternary and Tertiary basin units), (2) continental crust, (3) continental mantle, (4) oceanic sediments, (5) oceanic crust, and (6) oceanic mantle.

In addition to the Cascadia subduction interface, the Seattle fault was incorporated into these models because of its use as a seismogenic source in the Seattle Urban Hazards Maps (Frankel and others, 2007; fig. 4). The modeling demands for the smaller-scale Seattle maps also drove the more detailed, complex overall appearance of the Puget Lowland region in the current velocity models. The Seattle fault delimits the southern edge of the Seattle basin and thrusts crystalline crust over basin sediments, creating a sharp lateral velocity contrast. Its surface trace was extracted from Blakely and others (2002) and projected to a depth of about 20 km assuming a 45° south dip. This dip angle is a median value based on the range of dips published from seismic reflection surveys (Pratt and others, 1997; Johnson and others, 1999; ten Brink and others, 2002; Calvert and others, 2003). Additional crustal faults can be incorporated into the model as interest and additional information arise.

Published velocity information for the Cascadia region includes both regional V_P and V_S datasets, but there is limited overlap in the locations of the V_P and the V_S studies. In general, we used the available velocity data independently; however, in many of the geologic units, V_P is derived from V_S, or V_S from V_P, depending on data coverage. In units other than the continental sedimentary basins, the empirical relations of Brocher (2005) are used for the velocity conversion. The velocities within the Quaternary and Tertiary sedimentary basin units are described in detail in a later section, entitled “Continental Sedimentary Basins.”

Continental Sedimentary Basins

Continental sedimentary basin deposits are subdivided into Quaternary and Tertiary geologic units. The thickness of the Quaternary units through the southern Puget Lowland was constrained using the borehole data of Jones (1996) and interpreted depths from the marine seismic reflection data of Johnson and others (1999), including the detailed surface of the Seattle uplift and basin from Frankel and Stephenson (2000). For the Quaternary thickness through eastern Juan de Fuca Strait, the data of Mosher and Johnson (2000) were incorporated to create the Quaternary-Tertiary interface throughout the northern Puget Lowland.

Quaternary deposits in the Willamette Valley (including the Portland and Tualatin Basins) are generally less than 30 meters (m) in thickness and are not explicitly included in the model region. Future consideration of simulations requiring grid spacing less than 100 m should explicitly include a thin Quaternary layer. Additionally, recent gravity modeling has suggested that a significant thickness of lower-density sediment may exist in the Tualatin basin west of Portland, below the interpreted base of basin sediments in this model (about 6-km depth versus about 1.0-km depth in model V1.6; see McPhee and others, 2014). An image of the Cascadia model V1.6 sliced through the Puget Lowland is shown in figure 5.

The Quaternary V_P property model varied one-dimensionally with values of 1,500, 1,905, and 1,980 meters per second (m/s) at 0, 200, and 1,000 m depth, respectively. These values were derived from land surface measurements and high-resolution marine seismic surveys (Williams and others, 1999; Calvert and others, 2003). The Quaternary V_S property model is derived from V_{S30} and V_{P30} measurements at the surface to constrain V_P/V_S ratio to approximately 2.5. Setting this ratio to 2.5 in the near-surface is also consistent with average borehole measurements in the upper 150 m by Odum and others (2004). To ensure a contrast in V_S at the base of Quaternary deposits, the V_P/V_S ratio was set to 2.2 at 1 km depth. The minimum V_S in the Quaternary unit, including all non-ocean regions within the model volume, was constrained to 600 m/s as a limit for ground motion modeling, although numerous V_S measurements demonstrate lower V_S in the lowland basins (for example, Williams and others, 1999; Stephenson and others, 2012). The maximum V_S within the Quaternary unit was set to 900 m/s. The overall V_S -versus-depth structure of the Quaternary deposits is generally consistent with estimates from Odum and others (2004), Delorey and Vidale (2011), and Stephenson and others (2012) in the top kilometer.

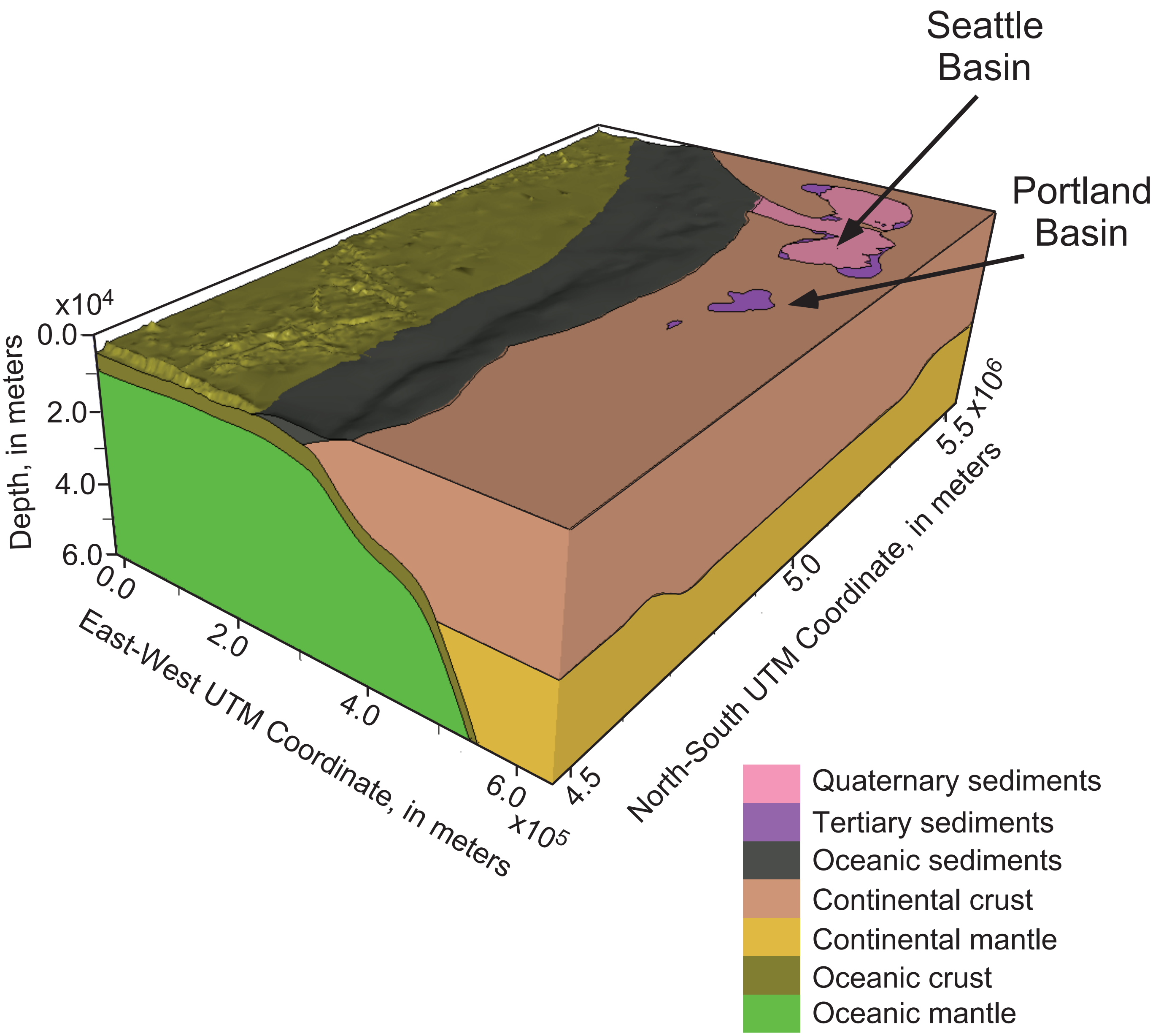

Figure 3. Geologic model volume including the Cascadia subduction zone. V_P and V_S property models cover the region from 40.2° to 50° N. latitude, 122° to 129° W. longitude, and from 0- to 60-km depth. Location of Seattle and Portland basins shown by arrows. Axes are annotated in Universal Transverse Mercator (UTM) zone 10 coordinates. Bathymetry (GEBCO, 2015) is included while topography above mean sea level (0 m) is excluded. Model projected into UTM zone 10 north coordinates, World Geodetic System 1984 (WGS84) datum. View shows the seven basic geology-based model units and their relationships at depth. Cascadia subduction fault surface is inferred along top of oceanic crust model unit.

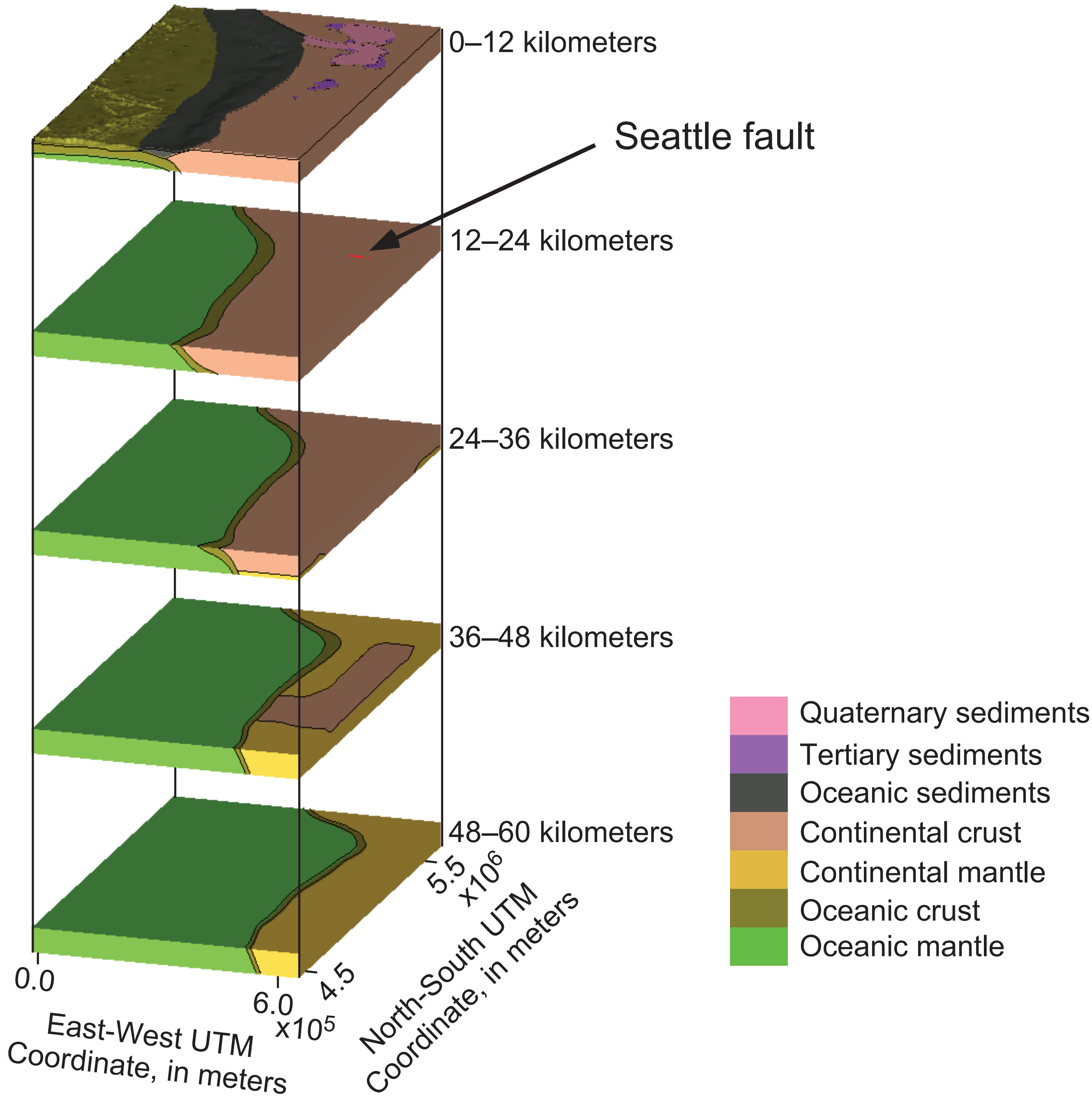

Figure 4. Horizontal subsections through Cascadia model V1.6. Each slab is 12 kilometers (km) thick. Model slabs are orthographically projected for comparison. Location of Seattle fault shown in 12–24 km slab as a red line, underlying the Puget Lowland basins. Slabs cover the entire model volume.

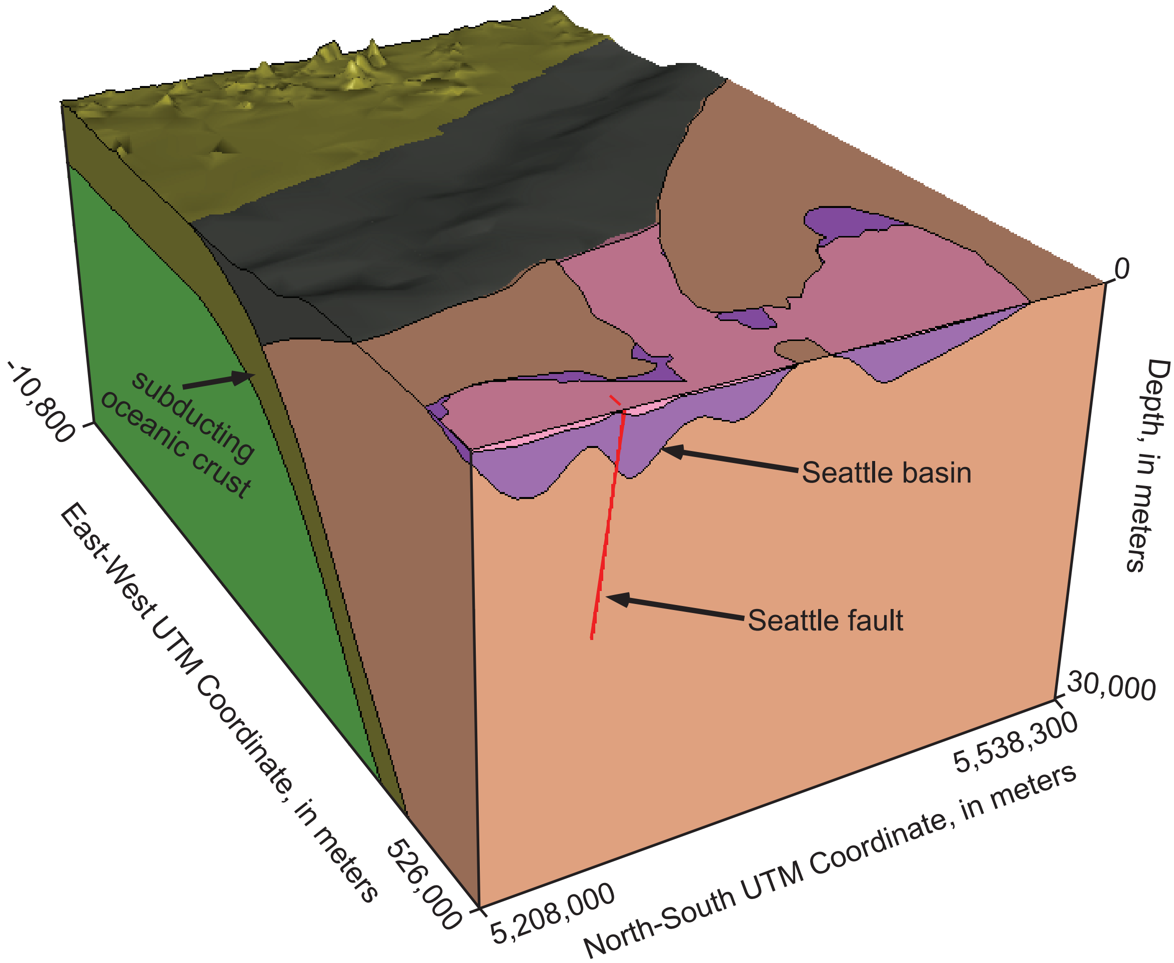

Figure 5. Sliced view of Puget Lowland with Seattle basin. Seattle fault (red line, dashed where projected to surface), and subducting oceanic crust are labeled. Vertical exaggeration is approximately 6X. The Seattle fault dips at 45° south within the model volume. Axes are annotated in Universal Transverse Mercator (UTM) zone 10 north coordinates. Oceanic mantle unit is green, oceanic crust is olive, oceanic sediments unit is gray, continental crustal unit is tan, Tertiary sediments unit is purple, and Quaternary unit is pink.

The base of the Tertiary sediments within the Puget Lowland is interpreted to be at the 4,500 m/s velocity contour, based on oil-industry borehole data (Brocher and Ruebel, 1998). This iso-contour surface was extracted from the Seismic Hazards Investigations in the Puget Sound (SHIPS) and earthquake data 3D P-wave tomography of Ramachandran and others (2006), which incorporate similar data from several previous tomography studies in the lowland (for example, Stanley and others, 1999; Brocher and others, 2001; Van Wagoner and others, 2002). The Portland area sedimentary basin thicknesses are derived from well data that intersect crystalline rocks under (generally) Tertiary deposits (Yeats and others, 1996; Gannett and others, 1998).

V_P of the Tertiary subunit in the Puget Lowland basins is defined by tomography of Ramachandran and others (2006). A constant V_P/V_S ratio of 2 was imposed on the Tertiary subunit to obtain V_S. This value was selected to ensure a distinct contrast in V_S at the contact between the continental crust and Tertiary geologic units that are broadly consistent with V_S interpreted by Snelson and others (2007). V_P parameters within the Willamette Valley basin deposits were similar to the velocity-versus-depth structure of the Puget Lowland with several exceptions. Because Quaternary-age deposits are not explicitly defined in the basins within the Willamette Valley, the upper 100 m was sufficiently lowered to represent "Quaternary-like" deposits. In a manner similar to our treatment of shallow V_P, V_S at the surface was set to approximate V_{S30} values in the Willamette Valley region using data from Odum and others (2010) to represent lower-velocity Quaternary deposits. A V_P/V_S ratio of 2 was imposed on the Tertiary subunit in this region to calculate V_P at the surface, to be consistent with the surface V_S values of Odum and others (2010), while V_S to the base of the valley sediments was calculated from V_P.

Continental Crust

The surface of the continental crust was set to mean sea level (MSL) outside of sedimentary basins and east of the oceanic sedimentary deposits (see fig. 3) because topography is not included in model V1.6. The surface of the continental crust below MSL was controlled by a smoothed continental shoreline and numerous published active and passive source seismic results along the continental margin (for example, Trehu and others, 1994; Clowes and others, 1997; Flueh and others, 1998; Fuis, 1998; Gulick and others 1998; Fleming and Trehu, 1999; Parsons and others, 1999; Stanley and Villaseñor, 2000; Bostock and others, 2002; and Ramachandran and others, 2006).

Two primary datasets were integrated to form the V_P and V_S property volumes within the continental crust. The SHIPS tomographic data (Ramachandran and others, 2006) formed the basis for V_P throughout the Puget Lowland region, while the tomographic data of Moschetti and others (2007) formed the basis of V_S throughout the remainder of the model volume. We once again rely on the empirical relationships between V_P and V_S of Brocher (2005) to calculate the companion property for both of these tomographic datasets. The final V_P and V_S property data were merged prior to volumetric gridding within the geologic unit. Although not directly incorporated into the property calculation, the V_P values calculated for the unit are broadly consistent with the numerous studies referenced above.

Continental Mantle

The top of the continental mantle is derived from data of Bassin and others (2000). These data were edited and smoothed to create the surface of this unit. Property V_S was derived from the tomography results of Moschetti and others (2007). The V_S tomography of Moschetti and others (2007) was used to define V_P throughout the geologic unit from the relationships of Brocher (2005). These V_P are generally consistent with the earlier tomography of Stanley and others (1999) from the Puget Lowland area, which was used to constrain upper mantle V_P in model V1.3.

Oceanic Sediment

The oceanic sediment unit represents the accretionary wedge, composed of accreted oceanic and continentally derived sedimentary deposits, which overlies the top of the continental crustal unit and the subducting oceanic crust. The eastern portion of the bathymetric surface was used to define elevation at the top of the oceanic sediment (figs. 3 and 5). Parameter V_P is derived from results of Parsons and others (1999) and numerous active-source marine seismic surveys (Trehu and others, 1994; Clowes and others, 1997; Flueh and others, 1998; Fuis, 1998; Gulick and others, 1998; Fleming and Trehu, 1999; Parsons and others, 1999; Stanley and Villaseñor, 2000; Bostock and others, 2002). Parameter V_P varies primarily as a function of depth. V_S was derived from V_P using the empirical relationship of Brocher (2005). The ground motion simulation study of Olsen and others (2008) suggests this unit will be subject to intense shaking during a Cascadia megathrust event, due in part to its proximity to the fault. Although this study used model V1.3, there are very minor differences in this unit's properties and geometry within model V1.6.

Oceanic Crust

The top of the subducting oceanic crust unit is defined by Blair and others (2011) and McCrory and others (2012). These data were merged with bathymetric data (GEBCO, 2015) west of the oceanic sediment terminus to create the upper surface of the oceanic crust, which in the subsurface is inferred to be the top of the Cascadia subducting slab. Based on available marine seismic-reflection profiling (for example, Fuis, 1998) and studies worldwide (for example, Turcotte and Shubert, 1982), the thickness of the oceanic crust was set to 5,000 m, which is likely on the low end of realistic values. Average velocity values derived from marine seismic surveys were extrapolated to obtain V_P (for example, Trehu and others, 1994; Flueh and others, 1998; Fuis, 1998; Gulick and others, 1998; Fleming and Trehu, 1999; and Ramachandran and others, 2006) and extrapolated uniformly to 60,000 m depth. V_S was derived from V_P using the empirical relationship of Brocher (2005).

Oceanic Mantle

The oceanic mantle is the only unit in the model underlying oceanic crust (fig. 4). The upper surface of the oceanic mantle unit is derived by down-projecting the top of the oceanic crust 5,000 m and smoothing the resulting surface to mitigate topographic anomalies from the bathymetry data. This unit is the least constrained in both V_P and V_S parameters because of limited published results. Based on the imaging results of Parsons and others (1999) and Flueh and others (1998), parameter V_P was set to vary from 7,900 to 8,300 m/s between about 10,000 and 60,000 m depth, respectively. V_S was derived from V_P using the empirical relationship of Brocher (2005).

Discussion

V_S and V_P throughout the model are shown in figures 6–9. V_S velocities range from 600 to 4,830 m/s. Figure 6 shows east-west oriented vertical slices through the V_S model, spaced every 200 km. These slices reveal the subducting slab and regions of the model with higher apparent resolution in the shallow continental crust such as western Washington State. In large part, this is due to the high resolution V_P tomography results from the SHIPS data (for example, Brocher and others, 2001; Ramachandran and others, 2006). Similarly, depth slices through the V_S property volume from 9,000 to 45,000 m spaced every 9,000 m, are shown in figure 7. The 9,000 m depth slice reveals the subducting oceanic crust as the arc-shaped orange-colored band of approximately 3,300 m/s. The region covered by the SHIPS tomography highlights the greater variability in the northeast quadrant of this slice beneath the sedimentary basins of the Puget Lowland. This subducting unit is visible in the depth slices to at least -45,000 m depth. Throughout the model volume, oceanic mantle V_S is consistently higher than continental units at a given depth slice. As shown in figures 8 and 9, the V_P property values range from about 1,100 to 8,450 m/s in the 3D property model. Many of the velocity trends and features observed in the V_S property slices are similar to those in the V_P property volume.

As of FY2017, model version V1.6 has undergone preliminary validation exercises (for example, Vidale and others, 2016) as part of the National Science Foundation funded M9 Project, a collaborative effort through the University of Washington whose goal is “to reduce catastrophic potential effects of a Cascadia megathrust earthquake on social, built and natural environments…” (https://hazards.uw.edu/geology/m9/). The model volume of model V1.3 in the immediate vicinity of Seattle, which is largely unchanged in model V1.6, was partially validated through qualitative waveform matching with ground motion simulations of the 2001 M6.8 Nisqually earthquake (to 1 Hz) as well as other weak-motion events (Frankel and others, 2007). The V_S and V_P model volumes were implemented in these ground motion simulations, and these results were incorporated into the U.S. Geological Survey (USGS) Urban Hazards Maps for Seattle. The Seattle urban hazard model volume was a subset of the greater Cascadia velocity model volume that is the focus of the M9 project.

The depth to shear-wave velocity of 2,500 m/s (Z2.5) is a parameter currently used for estimating long-period site response in international building codes (International Code Council [ICC], 2015). The Z2.5 parameter for the Puget Sound region from model V1.6 will be contributed to the database of Ahdi and others (2017), for building design parameters in the Pacific Northwest, as well as to the NCM (Boyd and Shah, 2016).

The ratio of P-wave velocity to S-wave velocity (V_P/V_S) throughout the geologic units is consistent with expected values as described in publications on the topic (for example, Turcotte and Schubert, 1982). The V_P/V_S depth slices, shown in figure 10, reveal that nominal ratios in the deeper crust and mantle range between 1.71 and 1.76. The mean V_P/V_S ratio between 8,000 and 60,000 m depth is approximately 1.734, similar to a Poisson solid value of 1.732 for elastic material. Property V_P/V_S varies most markedly at depths from about 9,000 m to the surface, where the ratio is as high as 2.5 in the upper few hundred meters, as described previously in the section on the Continental Sedimentary Basins unit.

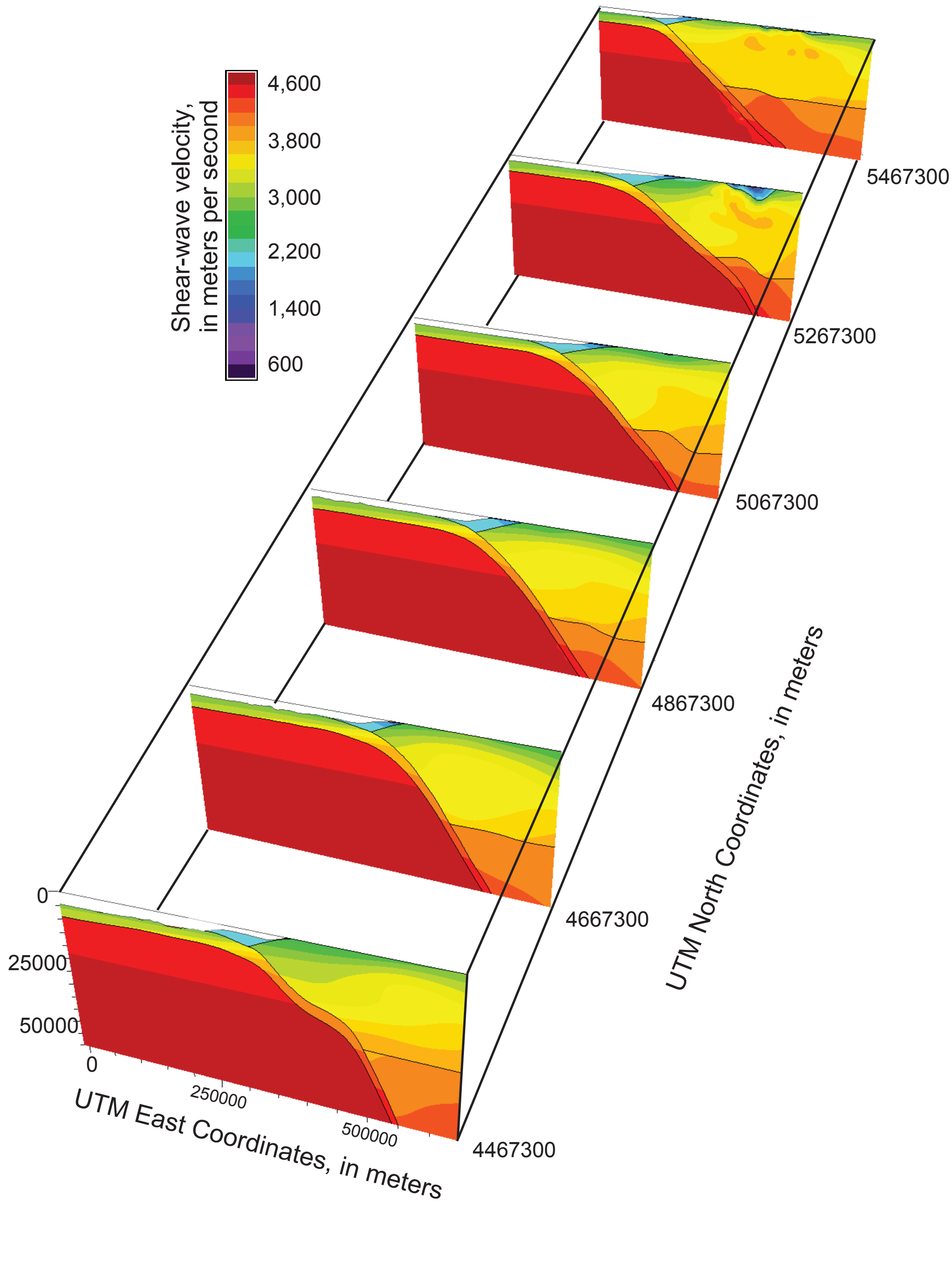

Figure 6. East-west slices through V_S model, spaced every 200 kilometers (km). Velocities are scaled from 400 to 4,800 meters per second (m/s). Water velocity of Pacific Ocean is set to 0 m/s.

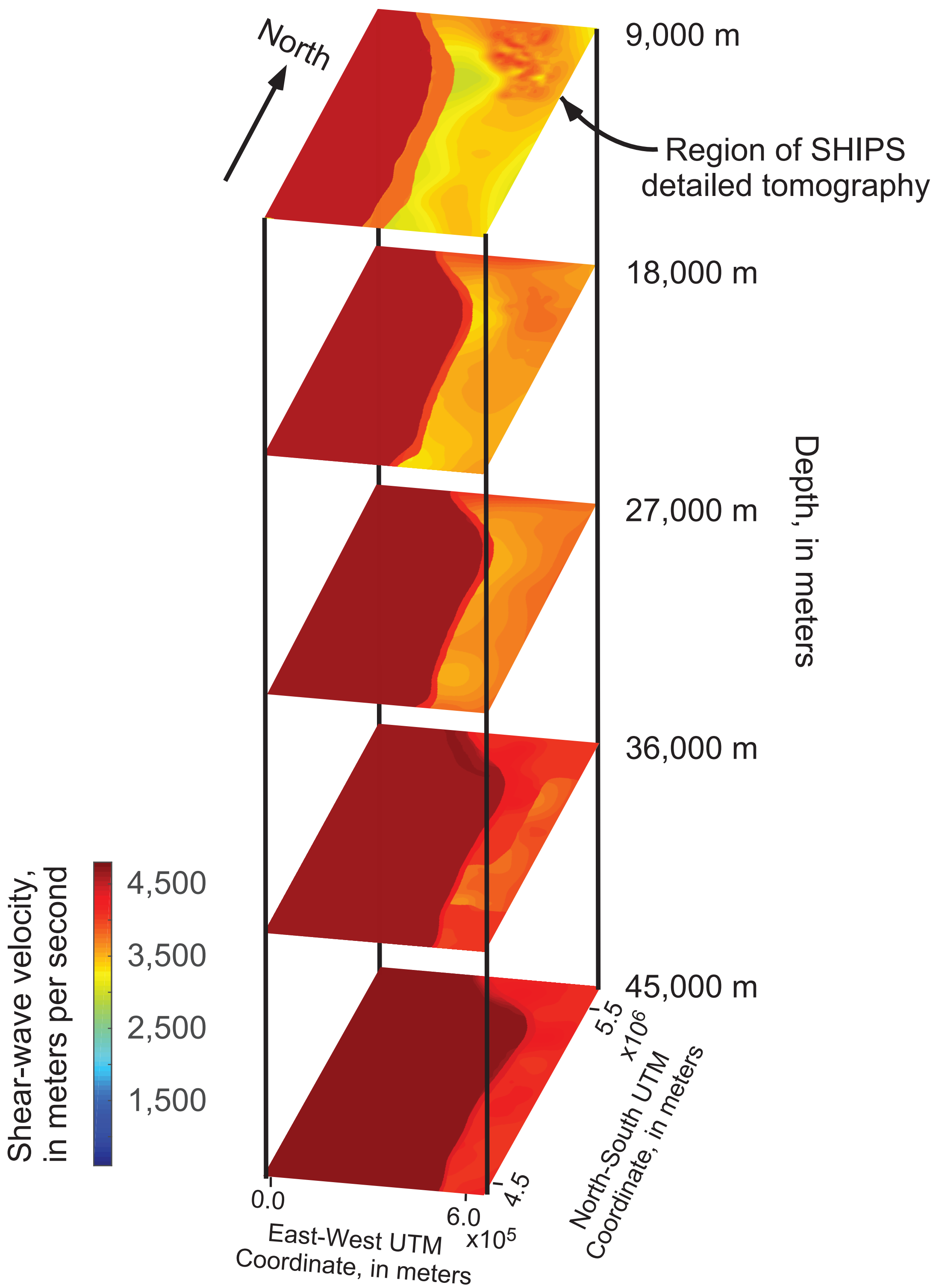

Figure 7. V_S horizontal model slices at 9,000 meter (m) to 45,000 m depth intervals, spaced every 9,000 m. Area of each slice covers entire extent of model.

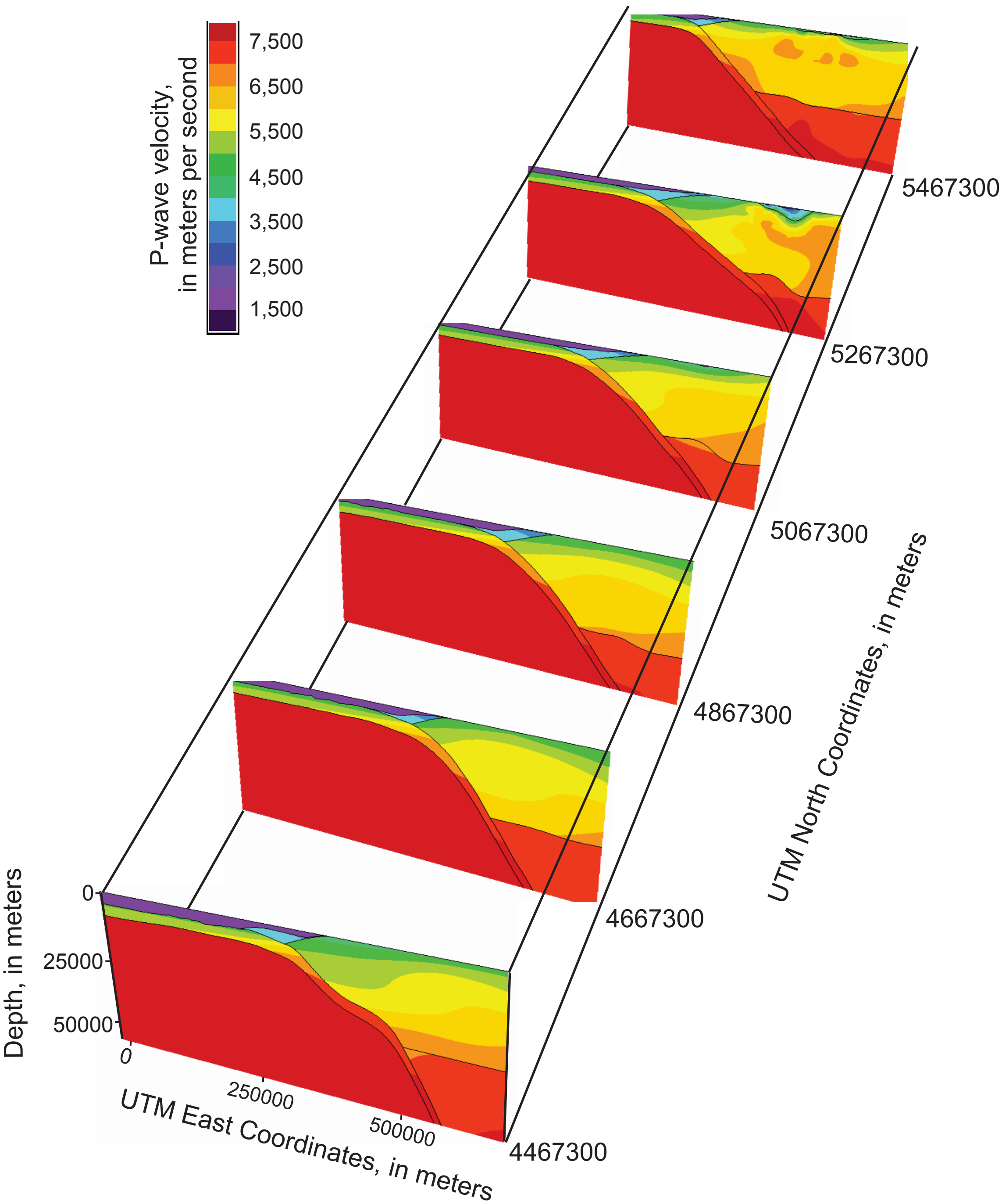

Figure 8. East-west slices through V_P model, spaced every 200 kilometers (km). Velocities are scaled from 1,500 to 7,500 meters per second (m/s). Water velocity of Pacific Ocean is set to 1,500 m/s. V_P property slices correspond in Universal Transverse Mercator (UTM) zone 10 north to the V_S slices in figure 6.

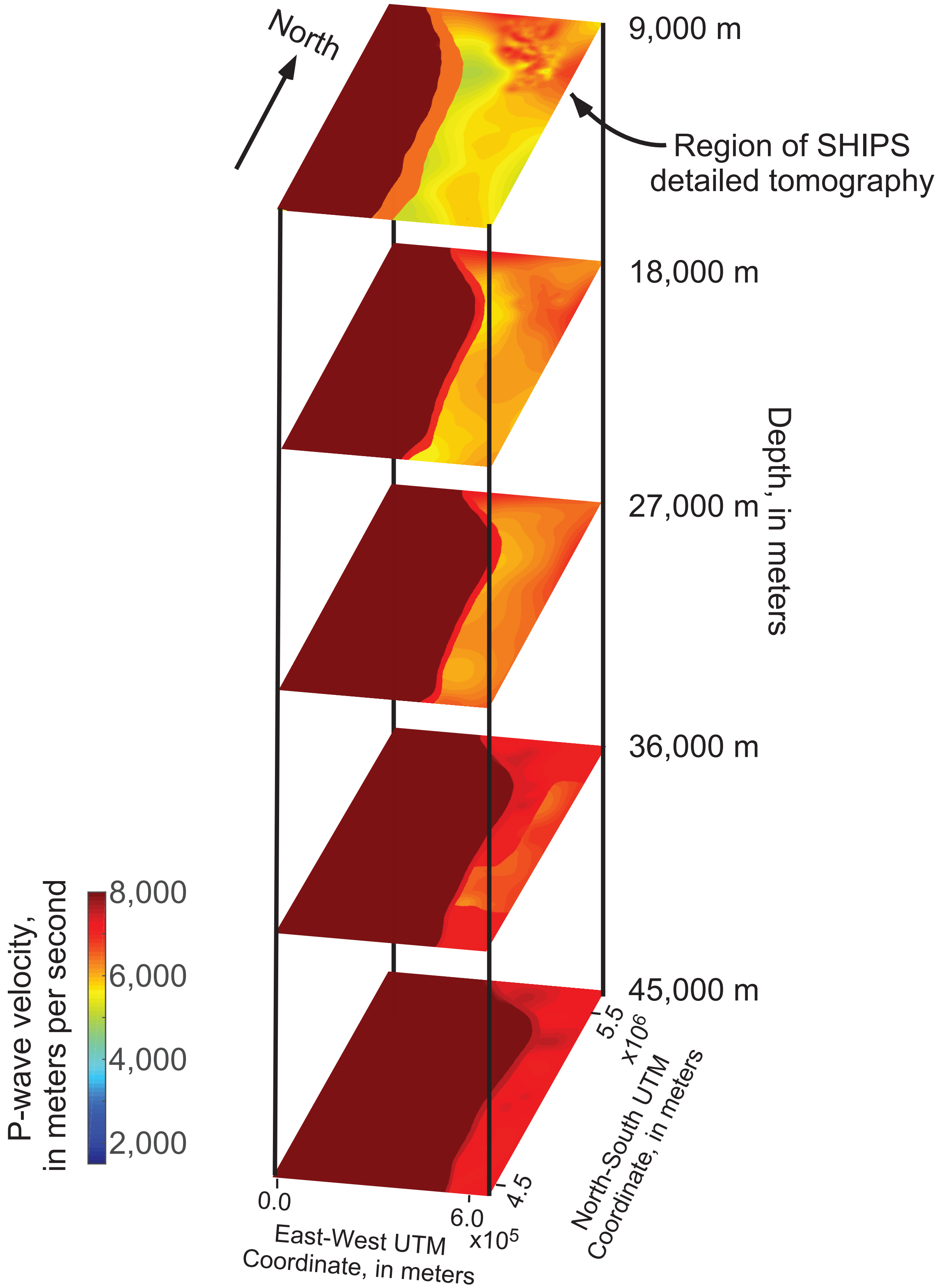

Figure 9. V_P horizontal model slices at 9,000 meter (m) to 45,000 m depth intervals, spaced every 9,000 m. Area of each slice covers entire extent of model. (Same depths as slices shown in fig. 7).

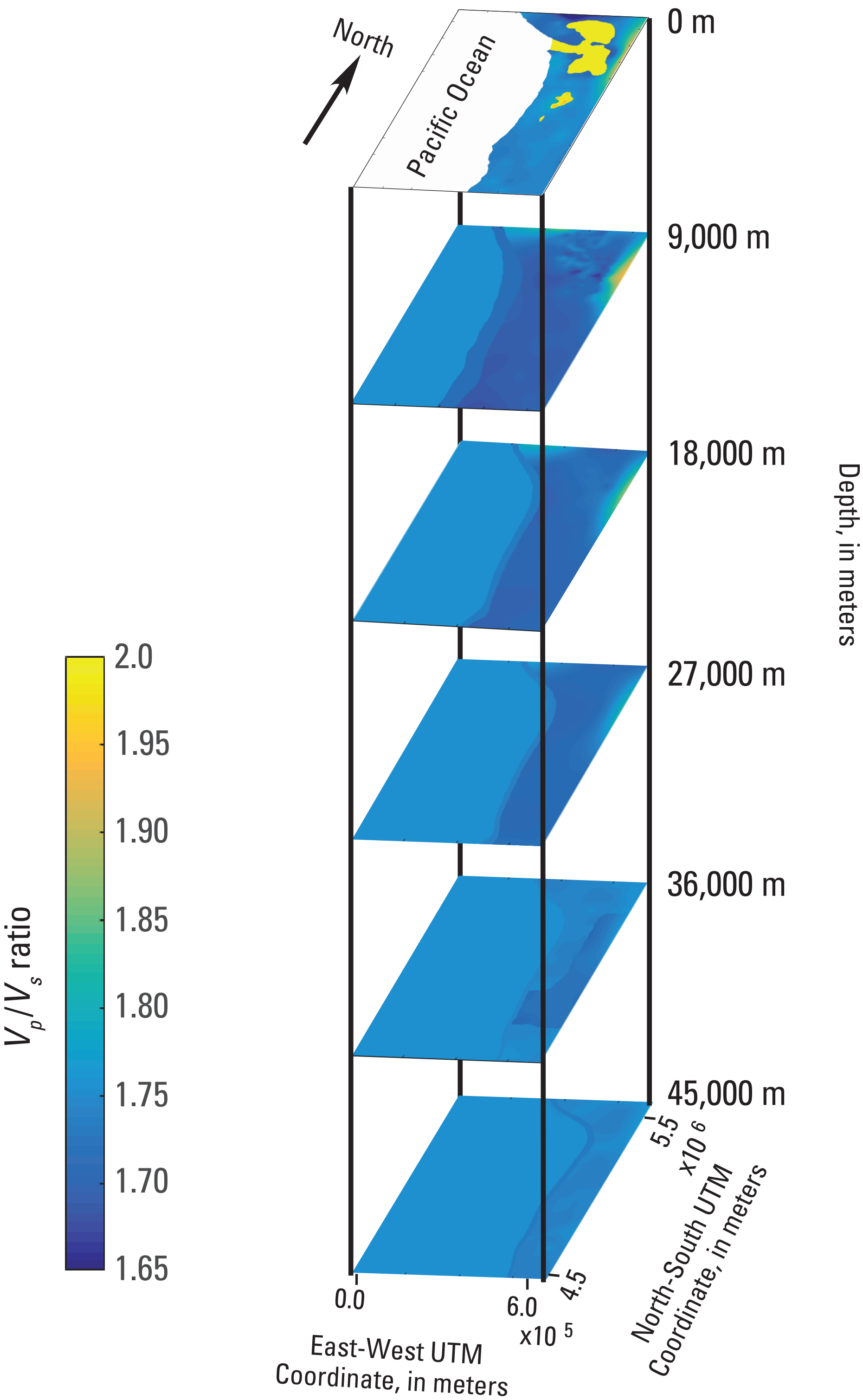

Figure 10. V_p / V_S horizontal model slices from 0 meter (m) to 45,000 m depth, spaced every 9,000 m. Area of each slice covers entire extent of model.

Summary

The 3D velocity property models described in this paper were developed between fiscal years 2010 and 2016 for use in strong ground motion simulations of the Seattle fault, Cascadia subduction, and similar earthquake events of interest. These models were derived primarily from published geophysical data in addition to borehole and other geological constraints. The model volume V1.6 as developed in EarthVision is designed to be flexible and can be modified to add further complexity as new published information becomes available or as scientific focus is redirected to new challenges in the Cascadia region. This flexibility allows model grid, or node, spacing to be customized from the EarthVision model for a user's specific purpose. The model can be obtained at 500 m resolution in zip-compressed ASCII format from ScienceBase (https://doi.org/10.5066/F7NS0SWM).

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