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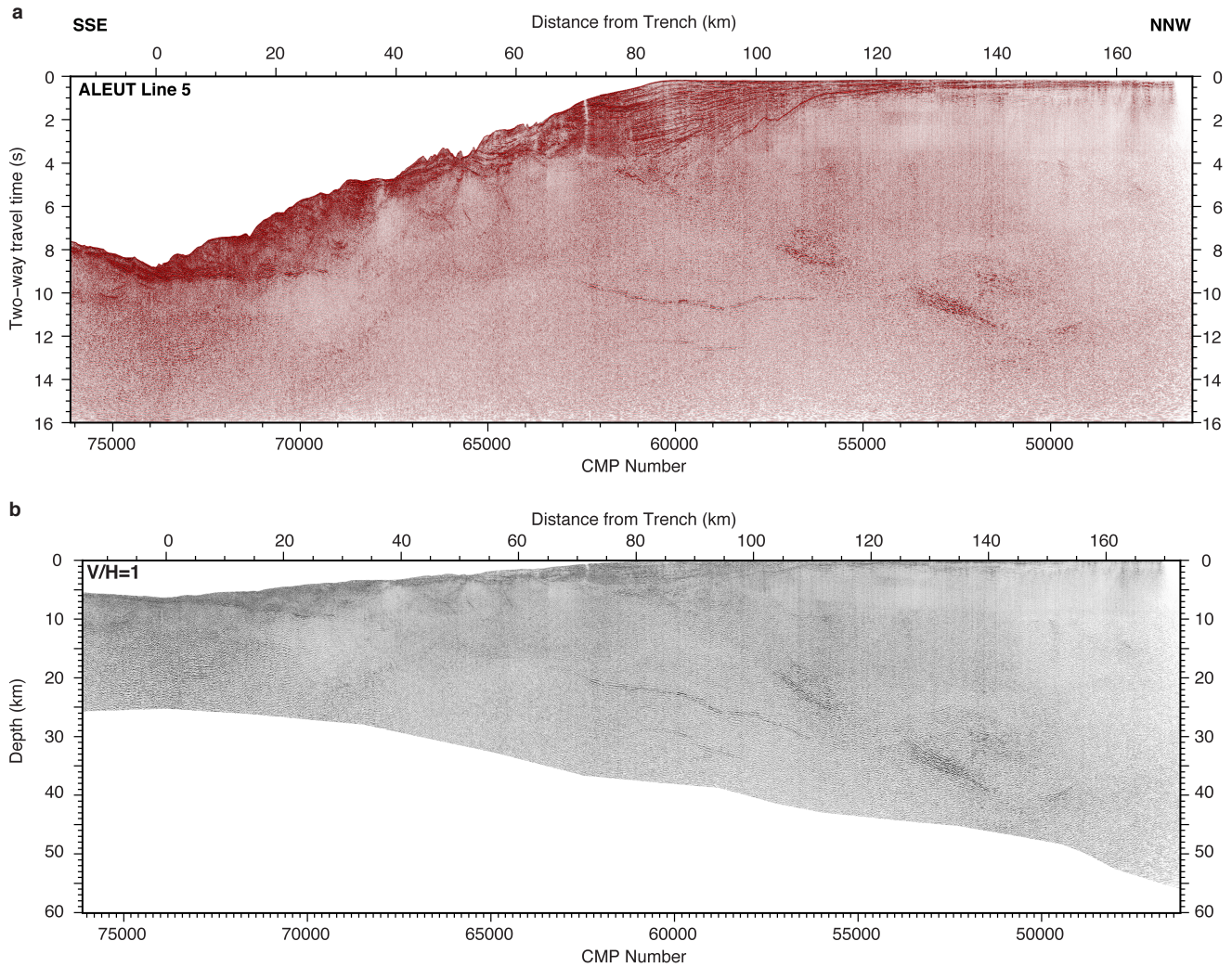
Tsunamigenic structures in a creeping section of the Alaska subduction zone

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The Supplementary Information includes the following figures:

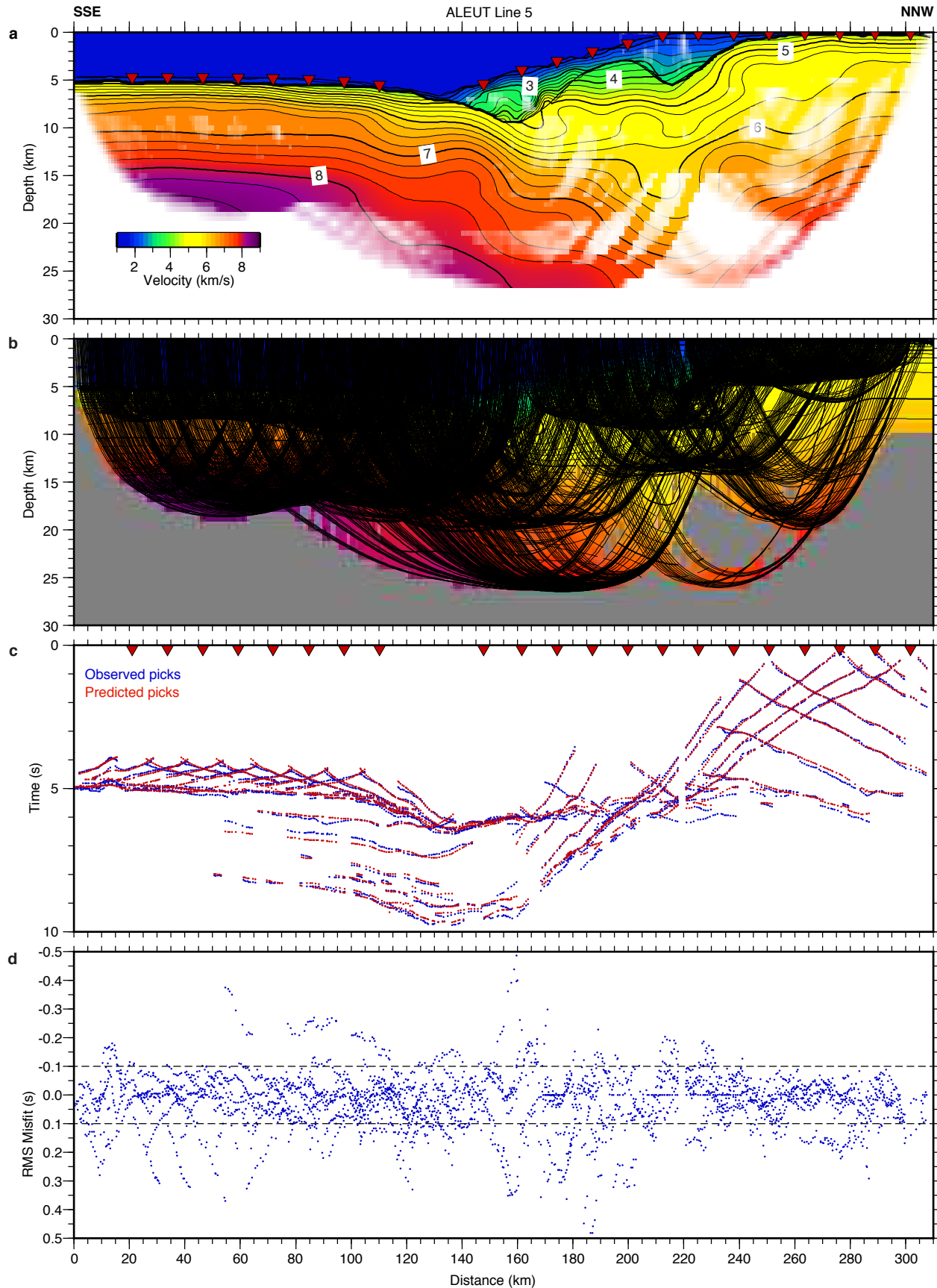
1. Figure S1: Time and depth sections of ALEUT Line 5 without interpretation.
2. Figure S2: First arrival tomographic model used for depth conversion of ALEUT Line 5.
3. Figure S3: Layered tomographic model showing the location of the plate interface and landward dipping normal fault with respect to the mantle wedge.
4. Figure S4: Time and depth sections of ALEUT Line 56.
5. Figure S5: Two zoom-ins on parts of the pre-stack depth migrated ALEUT Line 5 showing the landward dipping normal fault.
6. Figure S6: Two zoom-ins on parts of the pre-stack depth migrated ALEUT Line 6 showing the landward dipping normal fault and the first arrival streamer tomographic model used for the depth migration.
7. Figure S7: Shumagin seismic network and the recorded seismicity, 1982-1991 included the earthquake relocated in the 3D model from Abers [1994] (this study).
8. Figure S8: Minimum magnitude of catalog completeness showing that changes in the distribution of earthquake above magnitude 2.5-3 are robust.
9. Figure S9: Depth uncertainties of the subducting plate interface and crustal normal fault.

Figure S1



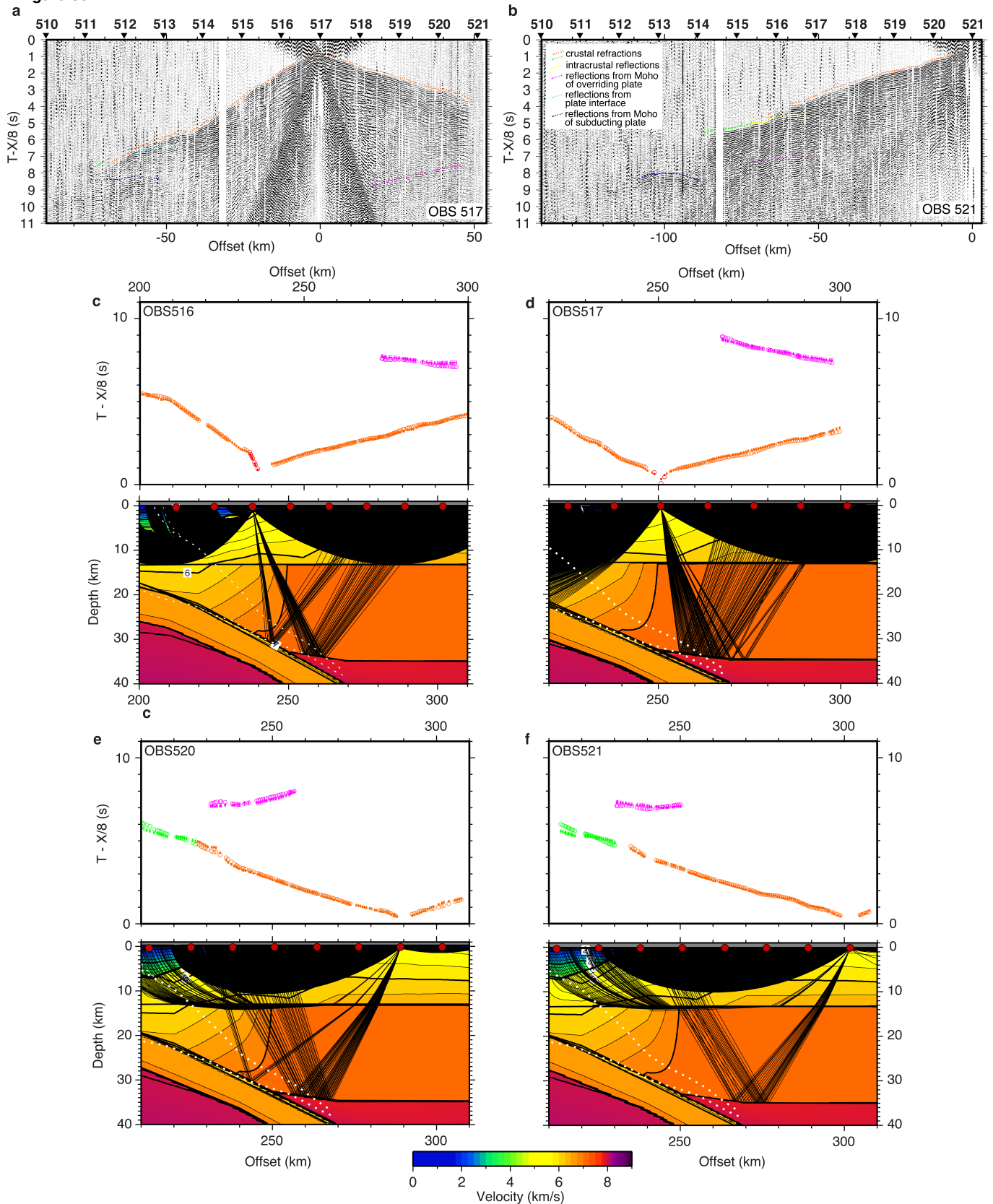
Supplementary Figure 1 | Time and depth sections of ALEUT profile 5. a. Post-stack time migrated section of ALEUT Line 5. For location see Fig. 1 and Supplementary Figs. 7-8 **b.** Post-stack time migrated section of ALEUT Line 5 converted to depth using the coincident first arrival tomographic model. Same as Fig. 2 but without interpretation.

Figure S2



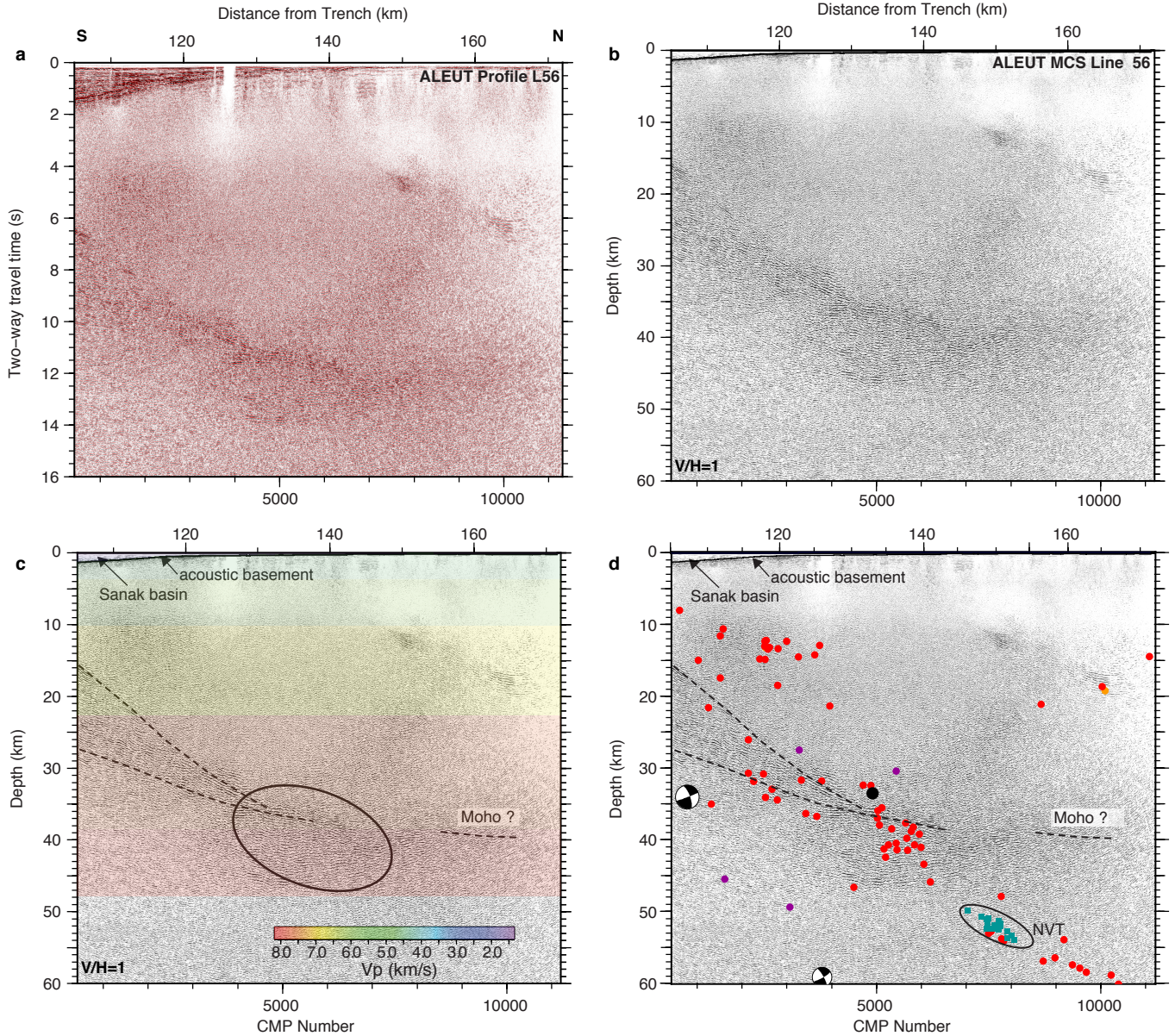
Supplementary Figure 2 | First arrival tomographic model. **a.** P-wave first arrival tomographic model for ALEUT Line 5 colored by velocity and contoured at 0.25 km/s. Interfaces shown with dark black lines and OBS indicated by inverted red triangles. See Fig. 1 for location. **b.** Ray paths over the model. **c.** Observed (blue) and predicted (red) travel times for all data used in the creation of the model. **d.** RMS misfit (s) for all data used in the creation of the model.

Figure S3

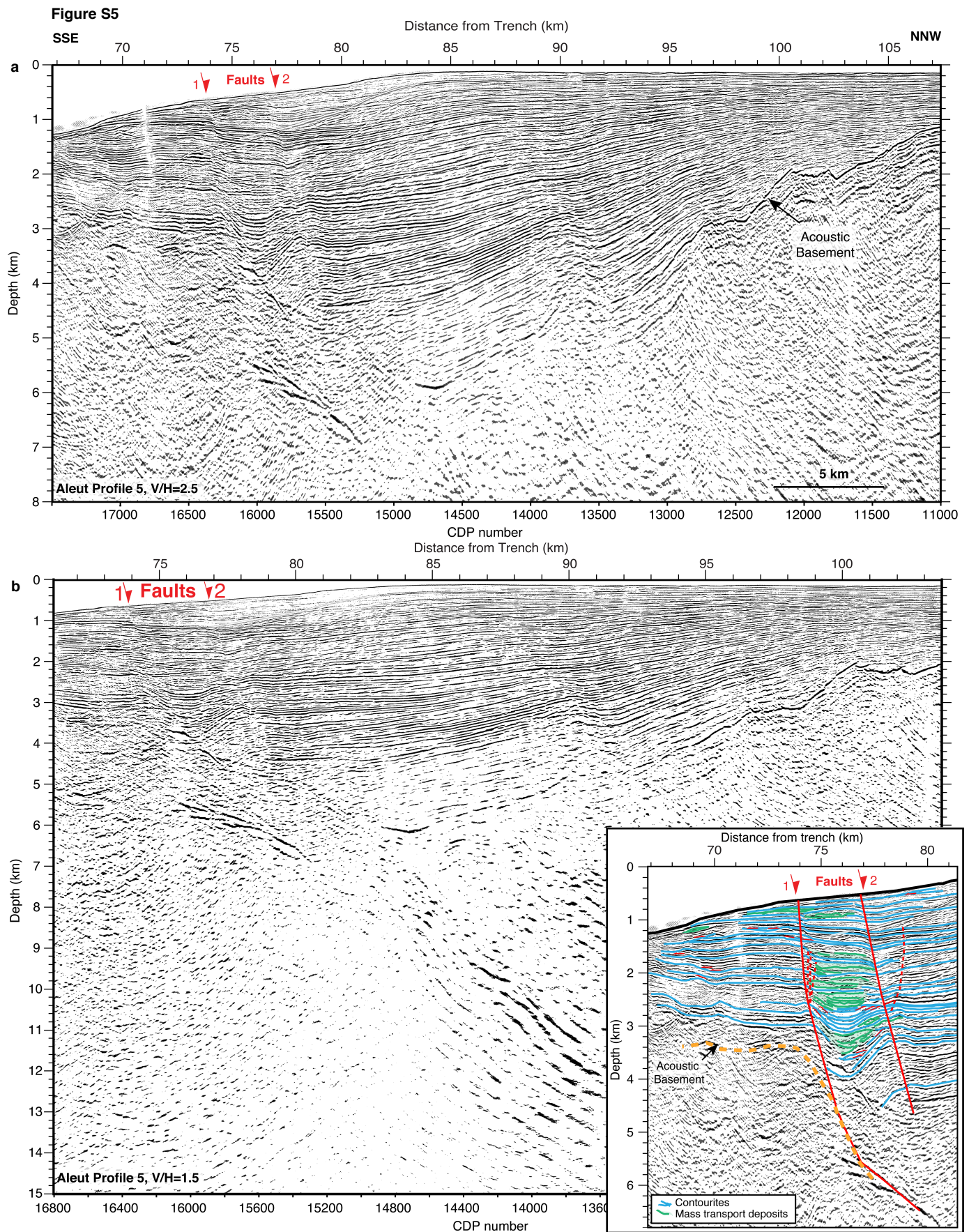


Supplementary Figure 3 | Layered tomographic model. **a.** Data example from the hydrophone of ALEUT OBS 517. **b.** Data example from the hydrophone of ALEUT OBS 521. **c-f.** Layered velocity model for which late reflected secondary arrivals such as reflections off the base of the continental plate have been considered to build this model with interfaces (i.e. velocity discontinuities). Top panels show observed (closed circles and bars to indicate pick uncertainties) and predicted (opened circles) travel times for hydrophones of OBS 516, 517, 520, 521. Crustal refractions are represented in orange, Sediment refractions in red and Moho reflections in purple. Bottom panels show ray paths in the layered velocity model. Large-scale normal fault in the overriding plate and plate interface boundary taken from Figure 2 are highlighted by dashed white lines.

Figure S4

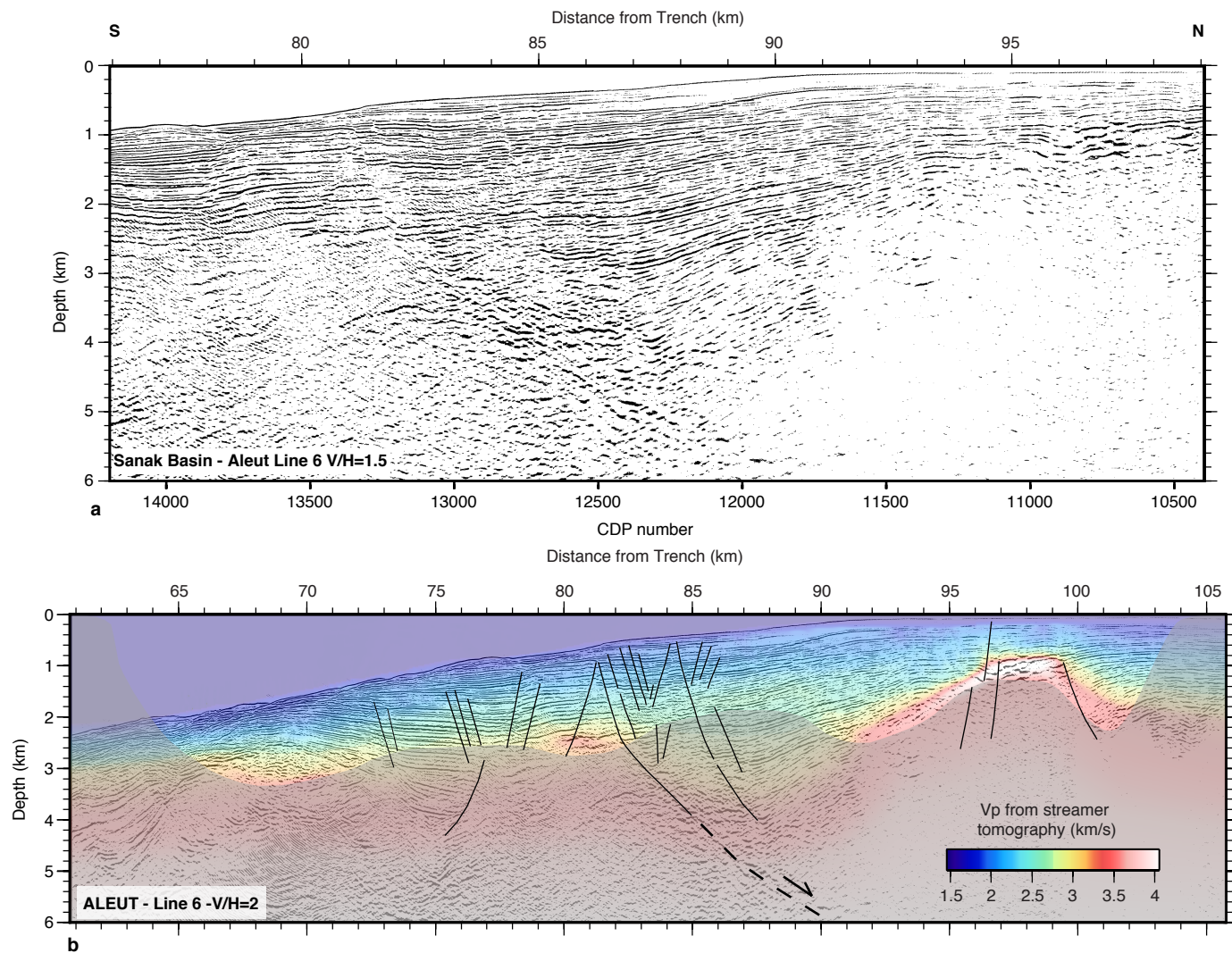


Supplementary Figure 4 | Time and depth sections of ALEUT Line 56. **a.** Post-stack time migrated section of ALEUT Line 56. See Figure 1 for location. **b.** Time migrated section converted to depth using the velocity from MCS data velocity picking for the sediments and a 1-D velocity model for the crust and upper mantle taken from Abers [1994]. **c.** Time migrated section converted to depth with the 1-D velocity model overlay. **d.** Time migrated section converted to depth. Hypocenters of local earthquakes within 15 km of the seismic line are superimposed on the depth section; Red dots are the earthquakes recorded by the Shumagin Network [Abers, 1992] and relocated in this study (See Supplementary Fig. 7 for locations). Purple dots are the earthquakes from the EHB catalog [Engdahl et al., 1998]. Events with focal mechanisms are from the CMT catalog (period 1976-2014). Blue diamonds highlighted by a black ellipse are Non-volcanic tremor (NVT) taken from Brown et al., [2013].



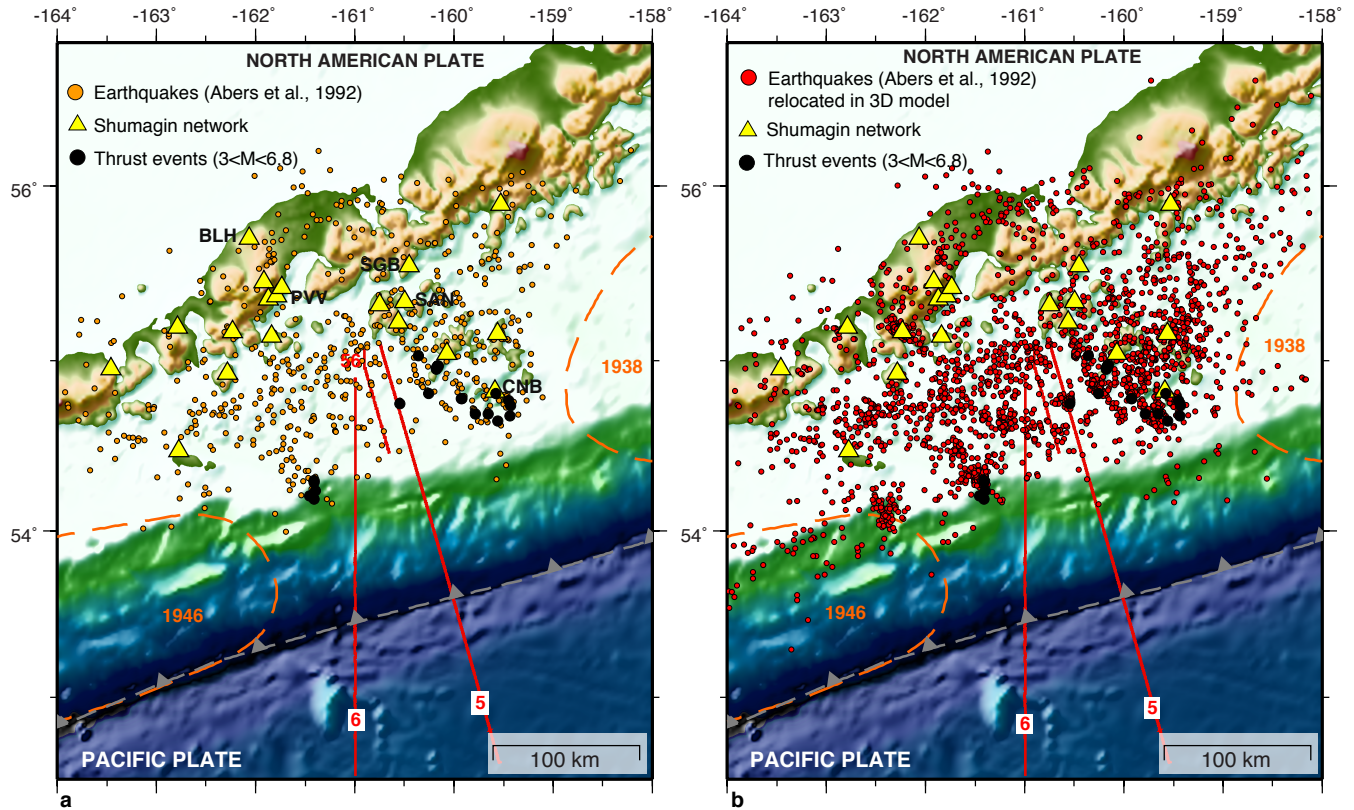
Supplementary Figure 5 | Two zoom-ins on parts of the pre-stack depth migrated ALEUT Line 5 (see location in Fig. 1). **a.** the structure of the Sanak Basin on the upper slope and **b.** the extent of the fault down to 15 km depth. Inset shows interpretation of the Sanak Basin near faults F1 and F2. A selection of bottom current controlled deposits (contourite drifts) are highlighted in blue. Flat U-shaped slope incisions, outlined by onlap terminations (red), correspond to contouritic moats. Toplaps terminations (in red) highlight periods of bottom current intensifications. The green areas show more chaotic facies and correspond to mass transport deposits filling the moats.

Figure S6



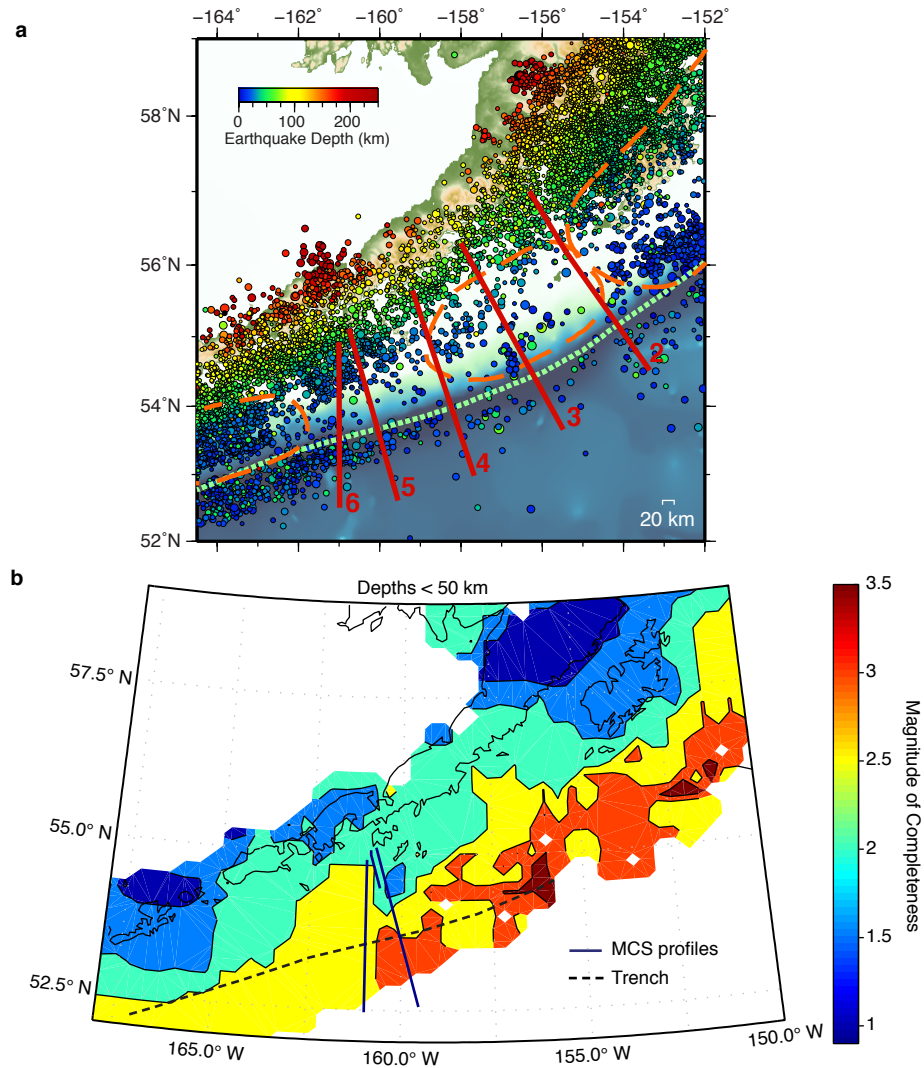
Supplementary Figure 6 | Two zoom-ins on parts of the pre-stack depth migrated ALEUT Line 6. a. Pre-stack depth migrated section of ALEUT Line 6 across the Sanak basin and associated buried basement ridge. **b.** Pre-stack depth migrated section of ALEUT Line 6. First arrival streamer tomographic model is superimposed on the depth section. This model was used for the pre-stack depth migration of the MCS data.

Figure S7



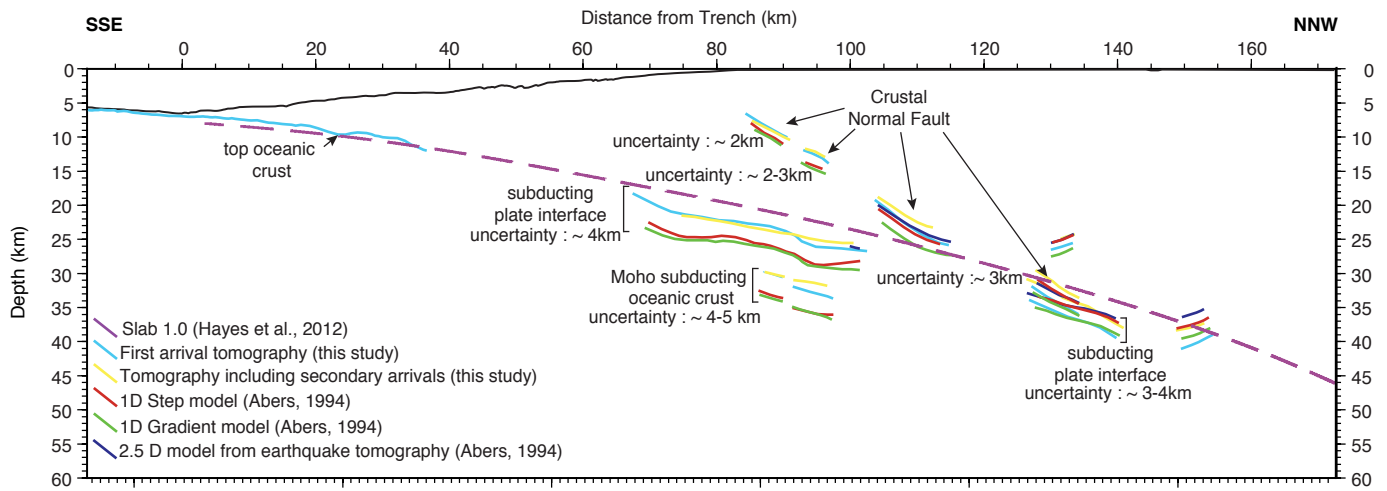
Supplementary Figure 7 | Shumagin seismic network and the recorded seismicity, 1982-1991. a. Orange circles represent earthquake locations obtained in a joint inversion for 3D velocity structure [Abers, 1994]. Black dots are notable events recorded by the Shumagin Network with thrust mechanisms ($3.0 < M < 6.8$) [Abers et al., 1995]. Labeled yellow triangles are three-component stations. **b.** Red circles are earthquake relocated in the 3D model from Abers [1994].

Figure S8



Supplementary Figure 8 | Minimum magnitude of catalog completeness. **a.** Seismicity from the Alaska Earthquake Information Center (AEIC) from 1990 to present shown with dots colored by depth and sized by magnitude. **b.** Maps of the minimum magnitude of catalog completeness (MC) calculated using the method of Wiemer and Wyss [2000] for 0-50 km depth range from Shillington et al. [2015]. Note that variations in seismicity with magnitudes greater than 2.5-3 are robust, indicating that observed downdip changes in seismicity do not arise from data coverage.

Figure S9



Supplementary Figure 9 | Spatial location of reflections generated at the interplate interface and the main crustal normal fault and imaged on the ALEUT Line 5 as obtained through depth conversion using the 5 different velocity models. The thick purple dashed line is the plate interface from Slab 1.0 [Hayes et al., 2012] and is given for comparison.

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