Fluid transport and storage in the Cascadia forearc influenced by overriding plate lithology

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Subduction of hydrated oceanic lithosphere can carry water deep into the Earth, with consequences for a range of tectonic and magmatic processes. Most of the fluid is released in the forearc where it plays a critical role in controlling the mechanical properties and seismic behaviour of the subduction megathrust. Here we present results from three-dimensional inversions of data from nearly 400 long-period magnetotelluric sites, including 64 offshore, to provide insights into the distribution of fluids in the forearc of the Cascadia subduction zone. We constrain the geometry of the electrically resistive Siletzia terrane, a thickened section of oceanic crust accreted to North America in the Eocene, and the conductive accretionary complex underthrust along the margin. We find that fluids accumulate over timescales exceeding 1My above the plate in metasedimentary units, while the mafic rocks of Siletzia remain dry. Fluid concentrations tend to peak at slab depths of 17.5 and 30 km, suggesting control by metamorphic processes, but also concentrate around the edges of Siletzia, suggesting that this mafic block is impermeable, with dehydration fluids escaping up-dip along the megathrust. Our results demonstrate that the lithology of the overriding crust can play a critical role in controlling fluid transport in a subduction zone.

Cascadia is an endmember subduction zone with a very young and hot subducting plate, capable of producing very large (moment magnitude $M_w \approx 9$) megathrust earthquakes1. The central forearc crust, generically referred to as Siletzia2, consists of thickened oceanic crust that accreted to North America in the late Eocene (Fig. 1). The late Tertiary Klamath3 and Wrangellia4 terranes respectively form the southern and northern domains of the Cascadia forearc. Siletzia is thickest in central northern Oregon and thins to the north5. In the Olympic Peninsula the full crustal section comprises accreted Tertiary sediments and metasediments, backstopped by a heavily deformed and tilted section of Siletzia6.

Cascadia is an archetype for episodic tremor and slip (ETS), characterized by bursts of non-volcanic tremor accompanied by low-frequency earthquakes and geoelectrically detected slow slip7 at or above the plate interface. There is substantial evidence8–10 that ETS occurs where effective stresses are orders of magnitude lower than lithostatic, which is most readily explained by overpressured fluids along or near the megathrust. Indeed, a low-velocity layer with anomalously high Poisson's ratios, also attributable to overpressured fluids11, has been detected within or slightly above the subducting oceanic crust in Cascadia12–14.

Although ETS occurs essentially everywhere in Cascadia, the intensity is reduced and recurrence intervals are longer beneath the thickened central core of Siletzia in central northern Oregon11. The same area is almost devoid of crustal and intraplate seismicity15, and may be more weakly coupled in the seismogenic zone15. This correlation of forearc crustal geology with ETS, seismicity and plate locking has been ascribed to variations in crustal permeability15,16 or variable hydration of the incoming plate16–22.

Seismic imaging provides numerous indirect constraints on fluids and fluid-mediated processes in subduction zones, allowing estimates of the abundance of hydrous minerals in the subducting plate23–25, forearc crust26,27 and mantle28, fluid content in the accretionary prism29–31 and volumes of overpressured fluids near the megathrust32–35 to be made. Magnetotelluric imaging of electrical resistivity can provide more direct constraints on the present distribution and connectivity of free fluids in the crust. Previous magnetotelluric studies in Cascadia have suggested along-margin variations in sediment subduction and high concentrations of fluids near the ETS zone and provided evidence for flux melting beneath the accretionary prism21,27,28 and volumes of overpressured fluids35. Our results are consistent with previous 2D inversion results from Cascadia32–34, albeit with less resolution of the shallow structure, given the limited bandwidth of long-period ($T < 10^4$ s, where $T$ is period in seconds) magnetotelluric data. However, the 3D model provides a more complete view of along-margin variations,
seen more clearly in Supplementary Fig. 1) are well documented towards the surface beneath the volcanic arc, beyond the east-ing C1. Finally, there are conductive upwellings (C3) that rise outside this area (Fig. 1). A deeper, higher-amplitude peak in images are in good agreement with the geometry of subducted cal edge of R1. In western Washington, the magnetotelluric places) under this thin layer, terminating at the nearly verti -cating abruptly to ~10 km in a layer that extends offshore. The and spatial context for the features seen in a single profile. The resolution of the offshore structure is also substantially improved owing to the inclusion of seafloor data. We focus on 3D variations in large-scale, deep crustal resistivity of the forearc, which are well resolved with our dataset.

Figure 2 reveals a conductive body (C1) extending from ~50–70 km offshore to an abrupt landward termination at ~20 km slab depth beneath a massive resistive body (R1). We interpret C1 as representing fluid-rich sedimentary and metasedimentary rocks of the accretionary complex, and R1 as representing comparatively dry mafic rocks of Siletzia. Indeed, the geometry of R1 is broadly consistent with geological and geophysical constraints on Siletzia, including its spatial extent\textsuperscript{49}, greater thickness in Oregon\textsuperscript{49, 50} and substantial disruption and unroofing of the mafic section in the Olympic Peninsula \textsuperscript{49, 51} (R2). In Oregon and southern Washington, Siletzia is very thick in the east, thinning abruptly to ~10 km in a layer that extends offshore. The conductive accretionary complex is thrust~50 km (more in places) under this thin layer, terminating at the nearly vertical edge of R1. In western Washington, the magnetotelluric images are in good agreement with the geometry of subducted sediments inferred from seismic tomography\textsuperscript{24} (Extended Data Fig. 6). Offshore, the conductivity of C1 is highest from 44~47° N; however, this may reflect the limited offshore data coverage outside this area (Fig. 1). A deeper, higher-amplitude peak in conductivity (C2) occurs in all sections shown at a slab interface depth of 30~35 km, sometimes shallower. C2 commonly appears as a second peak within a broader conductive layer encompassing C1. Finally, there are conductive upwellings (C3) that rise towards the surface beneath the volcanic arc, beyond the eastern edge of Fig. 2. These arc conductive features (which can be seen more clearly in Supplementary Fig. 1) are well documented in Cascadia\textsuperscript{38} and many other subduction zones\textsuperscript{39} but will not be discussed further here.

Resistive material extends beyond the southern edge of Siletzia into the Klamath terranes but changes to a relatively thin upper crustal layer (R3). Resistivity variations in this area are complex (Supplementary Fig. 1), with interlaced zones of high and low resistivity, consistent with the Klamath terrane’s origin as an amalgam of pre-Tertiary oceanic units with plutonic intrusions\textsuperscript{3}. Although the outboard edge is still dominated by conductive Franciscan material extending to the surface near the coast, the coherent accretionary complex seen along most of Siletzia was not imaged here. However, land magnetotelluric data are relatively limited in this area, and there are no offshore sites.

To provide a more complete view of the geometry of key features, we derived two plan-view images from the 3D model (Fig. 3a, b). First, we computed the depth to the bottom of the resistive bodies, defined by the 300Ωm isosurface (Fig. 3a). This revealed a series of 30~40 km-thick resistive blocks (a–e), distributed from Puget Sound to the inferred southern boundary\textsuperscript{39}, where a resistive curtain ‘f’ extends to the plate interface. This refines previous models of the deep geometry of Siletzia based on a single seismic refraction profile\textsuperscript{2}. These thick resistive blocks coincide with magnetic highs (Extended Data Fig. 7a), and they tend to align with high Vs above the plate interface (Extended Data Fig. 8). There is a sharp transition from the thin outboard edge of Siletzia to the much thicker blocks to the east, marking the abrupt termination of the under-thrust accretionary complex (C2). One exception to this picture occurs in central Oregon, where ‘g’ (R4; Fig. 2) extends to the plate interface near the coast, with thin Siletzia to the east underlain by a shallow conductor (C2).

The geometry of Siletzia revealed here is consistent with its hypothesized origin as a chain of seamounts\textsuperscript{39} or an oceanic
It may be due to post-accretion basaltic magmatism. There is a strong correlation between the imaged thickness of Siletzia and modern tectonic and magmatic activity. Faults in the forearc crust are shown by white lines and volcanic vents are marked by red symbols. The resistive blocks discussed in the text are labelled a–g. Conductance of the 10 km layer above the plate interface. Magnetotelluric sites are shown by small white circles, and conductive features discussed in the text are labelled A–I. The positions of highest (red crosses) and second highest (blue crosses) conductance peaks as a function of latitude are plotted over the ETS density for 2009–2019 (ref. 63). Patches where resistive material extends to the plate interface (from a) are outlined in green and the estimated position of the FMC is shown by the thick white dashed line.

A second view of the 3D model is provided by a map of conductance above the plate interface (Fig. 3b). High-conductance features parallel to slab contours, and aligned with the outer edge of Siletzia, extend from 45°–48°N (A–C in Fig. 3b). The northern terminus coincides with the limit of densest data coverage, and is not well constrained. The band continues to the southern edge of Siletzia, with decreased conductance except for the peak at ‘I’. These conductors are abruptly truncated down-dip by thick resistive blocks at slab depths ranging from 35 km in the Olympic Peninsula to 20 km in central Oregon, where the structure is more complex. Here, conductive feature ‘D’ is deeper (35 km slab depth) and sits in the ‘cavity’ formed by deep resistive features a, b, and g. Along the southern edge of Siletzia a thin band of high conductance (E) is located just up-dip and north of the resistive curtain. Farther south, in the Klamath terrane, conductor ‘F’ is at 35 km slab depth.

As summarized in Fig. 4a, conductance above the plate interface is systematically enhanced at three slab depths: (1) offshore (G–I, ~17.5 km), (2) near the FMC (A–D, F; ~30 km) and (3) beneath the arc (~65 km). We focused on the forearc peaks (1 and 2), which are plotted as a function of latitude on a map of ETS density in Fig. 3c. The positions of highest (red crosses) and second highest (blue crosses) conductance peaks as a function of latitude are plotted over the ETS density for 2009–2019 (ref. 63). Patches where resistive material extends to the plate interface (from a) are outlined in green and the estimated position of the FMC is shown by the thick white dashed line.
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...fluids flowing up the megathrust. The subducting oceanic crust is relatively dry in Cascadia, with at most 5 vol% structural water. We show in the Methods that the implied rate of fluid input, together with estimates of the fluid volume required to explain observed conductance (Fig. 4a), places a lower bound on fluid residence times of ~1 Myr. Thus, the main conductive features in Fig. 3b represent areas where fluids are sequestered, rather than source regions.

Within Siletzia the main areas of fluid storage are just up-dip of thickened resistive crust that extends to near the plate interface. We suggest that these fluids are sourced from dehydration reactions occurring at a relatively constant range of slab depths, near the FMC, and that Siletzia is relatively impermeable. Where these rocks extend to near the plate interface, fluids are transported up-dip along the megathrust, ultimately leaking out along the outer edge where they accumulate in metasediments (Fig. 5). Support for this conclusion is provided in Fig. 4b, where we plot above-slab conductance (Fig. 3b) averaged in wide strips along the margin. At latitudes where conductance (and fluid accumulation) is low near the source (27.5–37.5 km), more fluid accumulates up-dip (17.5–27.5 km). Even where the roots of Siletzia do not extend to the plate interface, peak conductance always occurs up-dip of the FMC, and the peak in tremor intensity (Figs. 3b,c and 4). In fact, metabasalt dehydration reactions occur over a range of depths, near and down-dip from the ETS zone. In our model (Fig. 5) dehydration fluids escaping into the crust move more rapidly up-dip than vertically owing to strong permeability anisotropy along and near the plate interface. As fluid accumulation volumes reflect an integral over source depths and time, conductance peaks are shifted systematically up-dip relative to the source region—by the greatest amount where impermeable thick Siletzia extends landwards into the source region.

Seismically imaged low-velocity layers near the plate interface in Cascadia and elsewhere have been interpreted either as a thin layer of fluid trapped in the upper oceanic crust or a thicker zone of fluid-saturated metasediments in the overriding crust; for example, see Extended Data Fig. 6. The magnetotelluric results are more consistent with the latter view. As illustrated in Extended Data Fig. 9, a 5-km-thick layer with a porosity of 2.7–4% as estimated for the low-velocity layer beneath Vancouver Island would have a conductance of 300–1,000 S, and cannot be present everywhere in the Cascadia forearc, as some have argued. However, such a layer could be present in places, and a thinner or less-conductive layer could be present over much of the forearc without contradicting the magnetotelluric data.

Seismic reflection images from southern Vancouver Island may provide insight into the nature of the conductive underthrust rocks. A zone of high reflectivity (E), interpreted as a zone of strongly sheared metasediments with sub-horizontal fluid-filled cracks, thickens from 2 km offshore where the megathrust is locked to a 5–7 km layer inland where deformation becomes aseismic. The conductive zones in Fig. 3b are probably similar, representing thick layered metasedimentary packages that are ductile, strongly sheared, laminated and filled with fluids. Indeed, the E layer beneath Vancouver Island is conductive.

As others have noted, the reduction in ETS frequency between 43 and 47°N (Fig. 3c) occurs beneath the thickest parts of Siletzia (Fig. 3a). This has been ascribed to reduced fluid pressures, due either to reduced hydration or permeability of the subducting plate or enhanced permeability of the overriding crust. However, the small seismically inferred variations in plate hydration or sediment water content (in both cases greater off Oregon) are inconsistent with increased fluid storage to the north, as we infer. It thus seems likely that fluid inputs are fairly uniform, and our inference that Siletzia is impermeable would actually suggest higher fluid pressures near the FMC in central Oregon.

A source of fluid is a necessary condition for ETS, if not sufficient alone. ETS most probably results from complex interactions in the...

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The text discusses the nature of fluid transport and storage in the Cascadia subduction zone, focusing on the role of dehydration reactions in metabasalt and their implications for seismicity and fluid distribution. The authors analyze conductive features in Magnetotelluric images and relate them to the structure and evolution of the forearc. They conclude that fluid inputs are fairly uniform and source regions are not where Siletzia extends landwards, suggesting impermeability.

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**Fig. 4** Profiles of conductance in a 10-km-thick layer above the upper plate interface. a, Conductance as a function of slab depth at fixed latitudes corresponding to the sections shown in Fig. 2 (coloured lines). The black dashed line shows average along-margin computed depth contours. The three nominal peaks (seaward, FMC and arc) are marked as 1, 2 and 3, respectively. The mean slab depths of the peak ETS density and FMC position are also marked by vertical grey dashed lines. b, Conductance from averaged over non-overlapping bands of slab depths (17.5-27.5 km and 27.5-37.5 km) as a function of latitude.
stressed rock–fluid system that involve fracturing, fluid movement and crack sealing by mineral precipitation. Variations in lithology (that is, Siletzia versus accretionary complex), with corresponding variations in rheology, rock strength and mineral dissolution and precipitation kinetics, may play an important role in controlling ETS intensity in Cascadia. There is some evidence that fault zone heterogeneity, with stronger asperities embedded in a more easily deformed matrix, may be a requirement for ETS. Thus, one possibility is that where Siletzia extends to near the plate interface, the subduction channel is narrower and more strongly sheared, resulting in fewer large asperities near the megathrust. It is also possible that increased reverse permeability of a more focused subduction channel allows more rapid up-dip fluid escape, and reduced fluid pressures in the ETS zone.

To make further progress, the magnetotelluric images should be more fully integrated with other geophysical constraints. The accretionary complex (mostly, but not completely, metasediments) and the competent rocks of Siletzia seem to have vastly different capacities for fluid storage, allowing magnetotelluric data to effectively map lithology, and hence to constrain spatial variations in rheology. Incorporating this information into geodynamic models might provide insights into seismicity, ETS and plate coupling in Cascadia and other subduction zones.

**Online content**

Any methods, additional references, Nature Research reporting summaries, source data, extended data, supplementary information, acknowledgements, peer review information; details of author contributions and competing interests; and statements of data and code availability are available at [https://doi.org/10.1038/s41561-022-00981-8](https://doi.org/10.1038/s41561-022-00981-8).

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Methods

Magnetotelluric data and inversion. Our magnetotelluric dataset includes 165 new sites (including 64 offshore) from the Magnetotelluric Observations of Cascadia with a Huge Array (MOCHA) project, straddling the continental margin in the central part of the Cascadia subduction zone (Fig. 1). These were supplemented with 142 EarthScope transportable array magnetotelluric sites1 and legacy long-period data from six 2D profiles (13 from EMSLAB2, 18 from CAFE-47, 13 from SWORSTM, 15 from KLMD5, 17 from POM6 and 10 from ABCS7). Most of the profile data are discussed in ref. 8. For the MOCHA onshore sites and the few profiles where spacing was typically 10–20 km, whereas for the offshore sites, profiles were ~40 km apart with ~20 km site spacing, except for the central profile at 44.25° N, which had a denser site spacing of 5 km. In total there were 393 long-period magnetotelluric sites, with data covering the period ranging from 7 s to 14,678 s. All onshore sites measured vertical magnetic fields; offshore sites did not. Data were processed with standard robust processing algorithms9–11. For the 3D inversions we used the ModEM code12. This inversion code allows specification of a prior model, deviations from which are penalized by the regularization. For results reported here the prior model consisted of a layered 1D Earth with a resistivity of 100 Ω m to a depth of 410 km, 104 Ω m from there to 660 km and 3 Ω m below this (Extended Data Fig. 1a). In the first layers of the starting model we included known bathymetry with the resistivity of seawater set to 0.34 Ω m (ref. 13). We also included a realistic oceanic sediment distribution14 (Extended Data Fig. 1d), with the electrical resistivity of the saturated sediments set to 1 Ω m.

Finally, we included the subducting Juan de Fuca plate in the prior model as a dipping resistive layer (Extended Data Fig. 1b), as in ref. 15. There is substantial evidence that oceanic lithosphere is generally relatively resistive16. Although resistive bodies are typically observed in inversions of magnetotelluric data from subduction zones17 without imposing this structure, magnetotelluric data cannot vertically resolve resistive bodies. Imposing the seismically constrained geometry of the plate in the prior model can improve the resolution of conductive features above the plate18. We took the depth to the top of the shallower parts of the plate (above 90 km) from ref. 19 and extended to greater depths using seismic tomographic models20. The thickness of the plate was set to 50 km on the basis of published models of resistive oceanic lithosphere21.

The model grid (Extended Data Fig. 1c) had a resolution of 11 x 9.5 km2 horizontally, with vertical layers logarithmically spaced, starting from very fine layers (20 m) to discretize the bathymetry and the seafloor sediments. The resulting core grid was 120 x 108 x 57 cells in latitude, longitude and depth, respectively. Edges were padded with seven logarithmically increasing grid cells on all sides to extend the boundary of the study area ~600 km in all directions. We ran the inversion more than 30 times to test the effects of various parameters (for example, the thickness of the slab, the effect of offshore sites, the effects of seafloor sediments and covariance parameters) and inversion strategies. Selected results are shown in Extended Data Fig. 5.

The seafloor data presented some challenges to the 3D inversions. The lack of short-period data made it difficult to constrain shallow structures such as the seafloor sediments. Inversion tests demonstrated that including a realistic distribution of conductive ocean sediments a priori (Extended Data Fig. 1d) was essential; anomalous phases of the nominal transverse electric (TE) mode (coast-parallel electric field) impedances, both for onshore and offshore sites near the coast could not be fit without imposing this structure. Noting that including a sediment layer greatly reduced the resistivity contrast at the seafloor, which is probably an important factor in improving the performance of the inversion. Even with the sediment layer imposed, fitting the offshore TE mode data was a challenge that we found could be mitigated with a two-stage inversion strategy: we first ran the inversion with large error floors on the nominal transverse magnetic (TM) mode (10% of the off-diagonal impedance), forcing the inversion to converge to a resistive fit to the TE mode data, for which we used a smaller (5%) error floor. In the second stage the inversion was restarted, using 5% error floors for both modes. The final normalized root-mean-square misfit with 5% error floors was 2.74, with the largest misfits for TE mode data localized on the seafloor and near the coast (Extended Data Fig. 4).

Results for the full dataset (observed and computed) are shown as maps of apparent resistivity and phase in Extended Data Figs. 2 and 3, along with site-by-site normalized root-mean-square for each impedance component in Extended Data Fig. 5.

Residence time for fluids. Assuming a 4-km-thick hydrated layer with 5 vol% water (ref. 22) and plate velocity of 0.3 m yr−1, the flux of bound water per metre width of plate was estimated as F = 0.05 x 4.00 x 0.03 = 6.0 m yr−1. To convert imaged ‘patch conductance’ C (conductivity integrated over the cross-sectional area) to crustal water volume Vf for the same patch we used Archie’s law23, assuming a fluid concentration of f = 0.30 (0.3 m of water per 1 m of sediment temperature). A simple calculation showed that for a cross-sectional patch of area A (in m2) and total conductance C, Vf = A1−σ σ (C/m)1/σ−1, where m is the exponent in Archie’s law. Assuming steady state, the minimum residence time of fluids in the high-conductivity patches is T = Vf/F. For the main conductive features in our inverse solution typical values for cross-sectional areas were A = 4 x 104 m2 and for total patch conductance C = 5 x 105 S m−1. For m = 1.3, 1.5 and 2.0 we found T = 1.0, 1.9 and 4.8 Myr. Although these calculations were very rough, the conclusion that fluids must be stored for >1 Myr was robust, especially given that some fluids are subducted to greater depths to drive arc magmatism (refs. 24, 25) or to serpentinize the forearc mantle (refs. 26, 27).

Data availability

The data that support the findings of this study are publicly available online at http://dx.iiris.edu/ds/products/emtf/. The electrical resistivity model file can be accessed online at https://doi.org/10.5281/zenodo.630337 Source data are provided with this paper.

Code availability

The 3D inversion code used for this study (ModEM) is freely available online at https://sites.google.com/site/modularem/

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Author contributions

D.W.L., K.K., A.S. and P.A.B. collected the MOCHA magnetotelluric data. A.K. processed the data and K.K. the marine data. B.Y. and B.P. ran the 3D inversions. G.D.E., B.Y. and P.A.B. developed the interpretation and wrote the manuscript with input from D.W.L. and K.K.

Competing interests

The authors declare no competing interests.
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Extended Data Fig. 1 | Graphical summary of prior model. (a) E-W cross-section, showing deep layered structure. (b) 3D geometry of resistive (1000 Ohm-m) subducting plate. Data from refs. 43,45. (c) Surface layer of prior model, showing top layer of ocean and actual grid resolution (11 × 9.5 km (N-S × E-W)). (d) Thickness of ocean sediment layers. Data from ref. 45.
Extended Data Fig. 2 | Observed (columns 1 and 3) and computed (columns 2 and 4) apparent resistivities for 4 representative periods. Left two columns are for the nominal TE mode, with current flow parallel to the coastline. Right columns are for nominal TM mode, with current flow perpendicular to coast. Plotted values are interpolated from values at sites using natural neighbor scheme.
Extended Data Fig. 3 | Observed (columns 1 and 3) and computed (columns 2 and 4) phases for 4 representative periods. Left two columns are for the nominal TE mode, with current flow parallel to the coastline. Right columns are for nominal TM mode, with current flow perpendicular to coast. Plotted values are interpolated from values at sites using natural neighbor scheme.
Extended Data Fig. 4 |Normalized root-mean-square (nRMS) misfit for each site. (a) total; (b) impedance components only; (c) VTF (Vertical magnetic Transfer Function) only; (d-f) nRMS for individual impedance and VTF components for coast parallel electric mode (nominal TE); (g-i) nRMS for individual components for coast perpendicular electric mode (nominal TM). In all cases nRMS is summed over period.
Extended Data Fig. 5 | Curved sections of the 3D resistivity model just above the upper interface of the subducting slab from various inversion runs. (a) run#36. (b) run#44. (c) run#45. Panel (d) shows a 3D view of the result shown in panel (c). For run#36 & run#44, the conductive ocean was allowed to vary during inversion, while for run#45 it was frozen. Note that run#44 & run#45 have more sites in Southwestern Oregon.
Extended Data Fig. 6 | Comparison between Vp from seismic tomography (a) and (b) and resistivity from the MT (c) and (d), along two profiles in Western Washington. Top panels: an east-west profile across the Olympic Mountains; lower panels, the CAFE profile (MT sites along this profile are shown in Fig. 1). Note that for the Vp plots cool colors are low velocities (a-b), and are interpreted as subducted sediments and metasediments. These should have low resistivities (hot colors in (c-d). There is a very good agreement between geometries imaged by the two geophysical methods.
Extended Data Fig. 7 | Comparison of resistive bodies to other geophysical data. (a) Pseudo-gravity derived from magnetics with contours (20 and 30 km) for depth to bottom of resistive body from Fig. 3a overlain. There is a good correlation between the 3D geometry of the core of Siletzia inferred from MT, and magnetic anomalies converted to pseudo-gravity. There is no clear correlation with resistive block 'e' but this body is under the thick (8 km) sedimentary Seattle basin, and is also outside our area of good data coverage. Deeply extending resistive bodies 'g' and 'f', also do not exhibit strong magnetic anomalies but these are likely not part of Siletzia per se, and may have different composition. (b) Crustal seismicity (M > 2, 1990–2020) from ANSS catalogue with the same resistivity contours overlain. Resistive blocks in the core of Siletzia are mostly aseismic, while block ‘e’ has little seismicity below the level of the Seattle basin. As is well known, there is almost no crustal seismicity in central-southern Oregon. This seismic gap includes the main thick block of Siletzia, but extends further south to the California border.
Extended Data Fig. 8 | Shear wave velocity averaged over 10 km thick layer above plate interface. Contours (20 and 30 km) of depth to bottom of resistor, and block labels from Fig. 3a are overlain. Updip of the FMC, where the 10 km thick layer is in the overriding crust, deep resistors inferred from the MT are generally seismically fast.
Extended Data Fig. 9 | Conductance \( C = \sigma_{\text{bulk}} H \) of a fluid layer, as a function of porosity \( \phi \) and layer thickness \( H \). We assume a fluid of conductivity \( \sigma_{\text{fluid}} = 30 \, \text{S/m} \) (salinity of seawater at ambient temperatures\(^7\)) and compute bulk resistivity using Archie’s law \( \sigma_{\text{bulk}} = \sigma_{\text{fluid}} \phi^m \) for \( m = 1.5, 1.75, 2 \) for the three panels (a, b and c). Colormap for conductance is identical to that used for Fig. 3b. Even with an Archie’s law exponent of \( m = 2 \) (panel c) conductance exceeds \( \sim 300 \, \text{S} \) for layer thickness\(^5\) and porosities\(^2\) previously postulated. The MT conductance maps (Fig. 3b) show that such a layer is not present everywhere, but a thinner layer, or one with lower \( \sigma_{\text{fluid}} \) could be. Note also that conductance of observed anomalies integrated over a 10 km layer, exceed peak values shown here, requiring either higher \( \sigma_{\text{fluid}} \), lower values of \( m \) or some combination.