



Resolution Limits of Global Seismic Tomography for Imaging the Flores Back-Arc Thrust: A Tectoglob3D-Based Assessment of the 2026 Mw 7.7 Flores Earthquake

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Abstract

The 15 August 2026, Mw 7.7 Flores earthquake, which occurred at a depth of ~15 km offshore northeast of Nagekeo, provides an important case for investigating active deformation along the Flores Back-Arc Thrust. In this study, we assess Tectoglob3D's capability and resolution for studying the seismic structure related to the earthquake sequence. We focus on the P- and S-wave TX2019slab models of [Lu et al. \(2019\)](#). Tomographic cross-sections to depths of about 750 km are compared with the spatial and depth distribution of earthquake hypocenters. The Vp and Vs models can successfully describe the first-order regional structure of the Sunda-Banda subduction system and its deep velocity anomalies. However, the tomographic images do not clearly resolve the shallow structures related to the Flores Back-Arc Thrust. Conversely, the earthquake distribution shows a clear concentration in the back-arc region, suggesting that active seismic deformation is more evident in the back-arc than along the main subduction zone to the south. Further, tomographic models do not reliably reconstruct earthquakes deeper than approximately 40 km. The results suggest a mismatch in scale/resolution between global tomography and localized earthquake structures. Therefore, the current tomographic presentation needs further adjustment for local-scale research. Earthquake relocation should be performed to improve hypocenter accuracy, followed by adaptive-grid local earthquake tomography, with mesh resolution optimized according to seismic-ray density. This approach should improve the imaging of shallow and localized Vp-Vs heterogeneities and better constrain the three-dimensional structure of the Flores Back-Arc Thrust.

Keywords: *Flores Earthquake, Tectoglob3D, TX2019slab-P-S, Seismic Tomography, Adaptive-Grid Tomography*

INTRODUCTION

A tectonic earthquake with a magnitude of Mw 7.7 occurred north of Flores Island, East Nusa Tenggara (NTT) at 4:58 a.m. WIB (5:58 a.m. WITA) on August 15, 2026. BMKG said the earthquake's focal mechanism indicated a thrust fault with an east-west orientation, typical of earthquakes along the Flores Thrust Fault (Figure 1). The event caused dozens of deaths and hundreds of injuries. It forced thousands of residents to evacuate, particularly in Sikka, Nagekeo, and Manggarai regencies in the days after the earthquake, according to data collected by the National Disaster Management Agency (BNPB).

The damage caused was extensive, impacting residents' homes, education and health facilities, government offices, and transport infrastructure. The magnitude of the impact and the long history of destructive earthquakes along the Flores Thrust Fault make it important to understand the earthquake faulting process. To do so, we need to model earthquake-source kinematics. This will help us understand the nature of the rock fracture that occurred and provide a scientific basis for explaining the patterns of shaking experienced, the potential for resulting tsunamis, and a learning tool for future earthquake disaster mitigation efforts ([Partini & Hidayat,](#)

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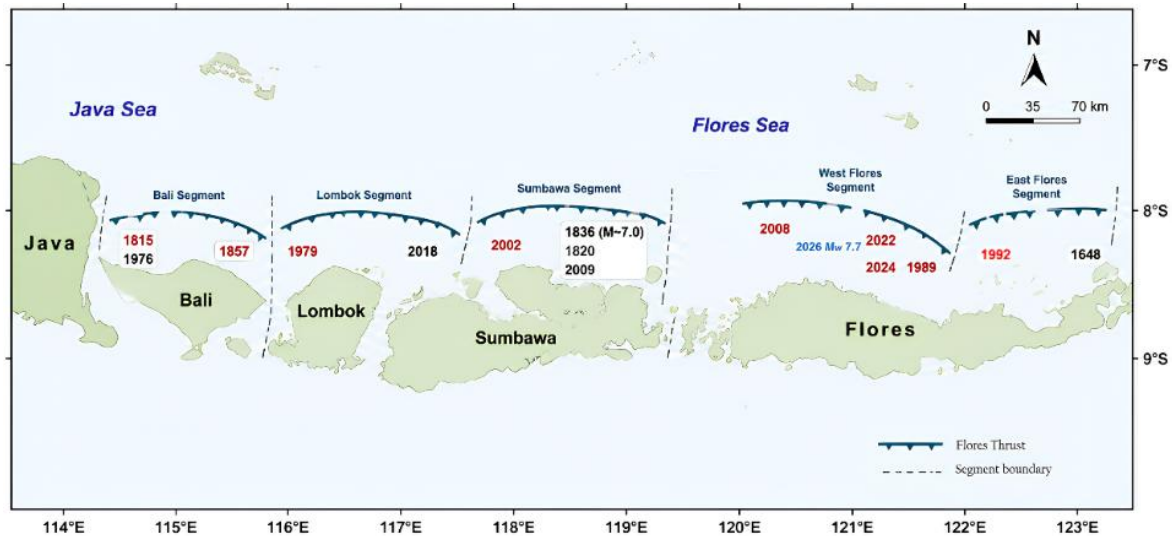


Figure 1. Significant activity along the Flores Thrust (adapted from [Sianipar et al., 2022](#))

The Flores Back-Arc Thrust (FBT), also called the Flores-Wetar thrust system, is one of the most important active back-arc structures in the eastern Sunda-Banda Arc of Indonesia ([Afif et al., 2021](#); [Andikagumi & Bradley, 2024](#); [Supendi et al., 2020](#)). The system accommodates much of the convergence between the Australian Plate and the Sundaland region and has produced destructive earthquakes, including the 1992 Flores earthquake (Mw 7.8).

Previous studies in geology, geodesy, seismology, and tomography have shown complex interactions between subduction, back-arc thrusting, and arc continent collision in the eastern Sunda-Banda Arc ([Andikagumi & Bradley, 2024](#); [Harris et al., 2020](#); [Harris & Miller, 2022](#); [Hasanah et al., 2024](#); [Supendi et al., 2020](#)). We need information on earthquake locations and source mechanisms, as well as a 3D image of the subsurface structure, to understand the relationship between the earthquake sequence and the active back-arc structure ([Harris & Miller, 2022](#)).

Seismic tomography is an important method for imaging seismic-wave velocity variations in the crust and upper mantle, allowing study of the spatial relationship between seismicity, lithospheric structure, and potential fault systems ([Hidayat et al., 2024](#)). A tomographic image in the Flores region is especially important, since the active back-arc seismicity occurs in a complex tectonic setting where the subduction system and the back-arc thrust interact.

Thus, analyzing tomographic P- and S-wave structures can provide regional context for interpreting the distribution and depth of earthquake hypocenters and evaluating whether the observed seismicity is associated with recognizable subsurface velocity anomalies ([Karakonstantis & Vallianatos, 2023](#); [Maneno et al., 2019](#)).

LITERATURE REVIEW

Regional and local seismic tomography have become important tools for resolving the three-dimensional architecture of subduction zones and arc continent collision systems ([Afif et al., 2021](#); [Hidayat et al., 2024](#); [Suhardja et al., 2024](#); [Widiyantoro & van der Hilst, 1997](#)). In the Sunda-Banda region, previous tomographic studies have consistently identified high-velocity anomalies associated with subducting lithosphere and low-velocity zones related to mantle processes, partial melting, and volcanic systems.

[Supendi et al. \(2020\)](#), for example, developed a three-dimensional P-wave velocity model from local earthquake tomography and identified a high-velocity slab extending to approximately

200 km depth, together with shallow and sub-slab low-velocity anomalies. Subsequent studies have progressively refined this regional tectonic framework using different datasets and spatial scales.

Recent tomography of the Sunda–Banda transition has demonstrated substantial lateral heterogeneity associated with the transition from oceanic subduction to continental collision and has imaged complex slab geometries extending into the upper mantle. [Hasanah et al. \(2024\)](#), using regional seismic tomography, imaged the Sunda–Banda transition to depths of approximately 750 km and showed that earthquakes are preferentially associated with high-velocity slab anomalies.

More recent investigations have also demonstrated that the Flores back-arc system is structurally complex at much shallower scales. [Andikagumi & Bradley \(2024\)](#), using relocated seismicity and geological constraints, developed a three-dimensional model of the Flores Thrust and demonstrated significant along-strike variations in fault geometry and seismogenic depth. Geodetic observations also indicate spatially variable deformation and coupling along the eastern Java–Flores and Flores–Wetar Back-Arc Thrust systems ([Zhao et al., 2025](#)).

Collectively, these studies show that the tectonic architecture of the Sunda–Banda transition is strongly scale-dependent: regional tomography resolves lithospheric and upper-mantle structures, whereas relocated seismicity, local tomography, and geodetic observations are needed to characterize shallow fault geometry and localized deformation.

Tectoglob3D provides an accessible framework for visualizing several global seismic tomography models, including GAP-P4, S362-ANI, TX2019slab-P/S, and Seisglob2. This study focuses on the TX2019slab-P and TX2019slab-S models ([Lu et al., 2019](#)), which represent P- and S-wave velocity anomalies relative to AK135 and have a nominal lateral resolution of approximately 1°. Although these models provide a useful first-order representation of large-scale subduction-related structures, their effective spatial resolution differs fundamentally from that achieved by local earthquake tomography and relocated seismicity.

Despite recent advances in imaging the Sunda–Banda transition and reconstructing the geometry of the Flores Thrust, a systematic assessment of how global-scale tomographic models represent a localized, shallow, and structurally complex earthquake source region along the Flores Back-Arc Thrust remains limited ([Liu et al., 2026](#)). This constitutes the specific research gap addressed here.

Rather than developing another regional tomographic model, this study critically evaluates the capability and limitations of Tectoglob3D, particularly the TX2019slab-P and TX2019slab-S models, in representing the velocity structure associated with the 15 August 2026 Flores earthquake sequence. By comparing tomographic cross-sections with the spatial and depth distribution of seismicity, the study identifies the scale and resolution mismatch between global tomography and localized back-arc deformation. It establishes the methodological basis for subsequent earthquake relocation and adaptive-grid local earthquake tomography.

RESEARCH METHOD

The methodological framework was designed to evaluate the capability and resolution limitations of global seismic tomography available through Tectoglob3D in representing the regional seismic structure and localized seismicity associated with the Flores Back-Arc Thrust. This study evaluated the TX2019slab model ([Lu et al., 2019](#)).

The TX2019slab model is a tomographic model that performs simultaneous P- and S-wave inversions and hypocenter relocation while accounting for the thermal effects of slabs in the Earth, thereby producing a sharper velocity model in subduction slab regions. This tomographic inversion uses 553,000 global events from 1966 to 2008. The tomographic grid is 275 km × 275 km, with the z-dimension ranging from 75 to 240 km.

Earthquake data were obtained from the International Seismological Centre (ISC) catalog for

the period 1964–2026. A total of 1,417 earthquakes (Mw 4.2–8.3) within approximately 4°–12°S and 116°–127°E were analyzed, with hypocentral depths extending from shallow crustal levels to approximately 700 km (Figure 2). This domain covers Flores and the surrounding Sunda–Banda Arc, including the main subduction zone to the south and the Flores Back-Arc Thrust to the north.

Attention was given to the 15 August 2026 Mw 7.7 Flores earthquake, located at approximately 15 km depth offshore northeast of Nagekeo, and the spatial concentration of seismicity around its source region (Figure 1). The 1,417 events were used as a long-term regional seismicity dataset rather than being interpreted as aftershocks of the 2026 earthquake.

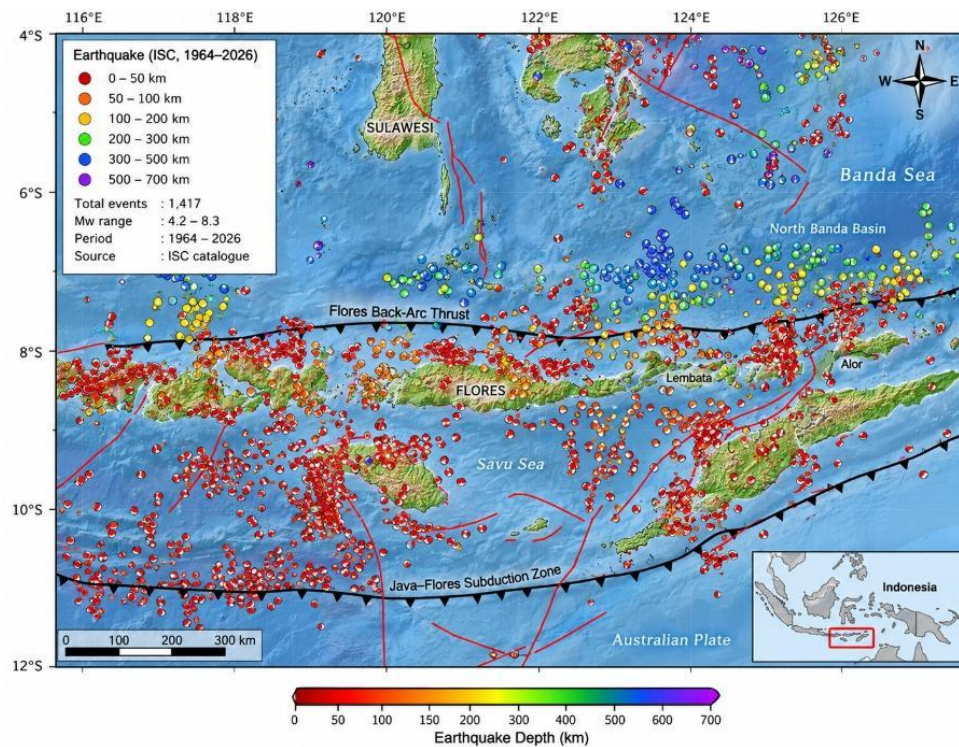


Figure 2. Spatial distribution of 1,417 ISC earthquakes (Mw 4.2–8.3) recorded during 1964–2026 within 4°–12°S and 116°–127°E.

The analysis comprised three complementary stages. First, the TX2019slab-P and TX2019slab-S models available through Tectoglob3D were examined to characterize the first-order three-dimensional velocity structure beneath Flores and the Sunda–Banda Arc. These models represent P- and S-wave velocity perturbations relative to AK135 and have a nominal lateral resolution of approximately 1°. Horizontal slices and vertical cross-sections extending to approximately 750 km depth were used to identify the principal velocity anomalies associated with the regional subduction system.

Second, the spatial and depth distributions of the ISC earthquakes were qualitatively compared with the P- and S-wave velocity anomalies to assess their relationships with the subducting lithosphere and shallow back-arc seismicity. Particular emphasis was placed on whether the models could represent the localized seismicity associated with the Flores Back-Arc Thrust.

Third, the resolution of the global tomographic models was evaluated against the spatial scale, clustering, and depth distribution of the observed seismicity. This comparison helped distinguish large-scale lithospheric structures that global tomography can reasonably resolve from shallow, localized fault-related structures that may lie below its effective resolution.

Accordingly, this study does not construct a new tomographic model or perform earthquake relocation; instead, it evaluates what structural information Tectoglob3D can and cannot resolve at the regional-to-local scale. The mismatch between the resolution of the global models and the scale of localized earthquake clusters supports recommending earthquake relocation followed by adaptive-grid local earthquake tomography as a future improvement. By adapting model parameterization to seismic-ray density, this approach is expected to improve resolution of shallow and localized Vp–Vs heterogeneities and provide tighter constraints on the three-dimensional geometry of the Flores Back-Arc Thrust.

FINDINGS AND DISCUSSION

Three-Dimensional Tomography

The P- and S-wave cross sections extend to ~750 km depth and provide a first-order image of the seismic structure beneath the Flores region in the Sunda-Banda Arc. These sections are extracted from the P- and S-wave models TX2019slab by [Lu et al. \(2019\)](#) and represented with Tectoglob3D. The Vp and Vs models show broad-scale velocity heterogeneities and deep high-velocity anomalies that are related to the regional subduction system (Figure 3 and Figure 4).

However, the anomalies are relatively smooth and diffuse compared to the observed earthquake distribution, especially in the shallow part of the section. The difference points to the scale of the TX2019 slab model, which is largely intended to image global mantle structures and subducting slabs, not localized crustal fault systems. Therefore, small-scale features associated with the Flores Back-Arc Thrust may be smeared or poorly resolved.

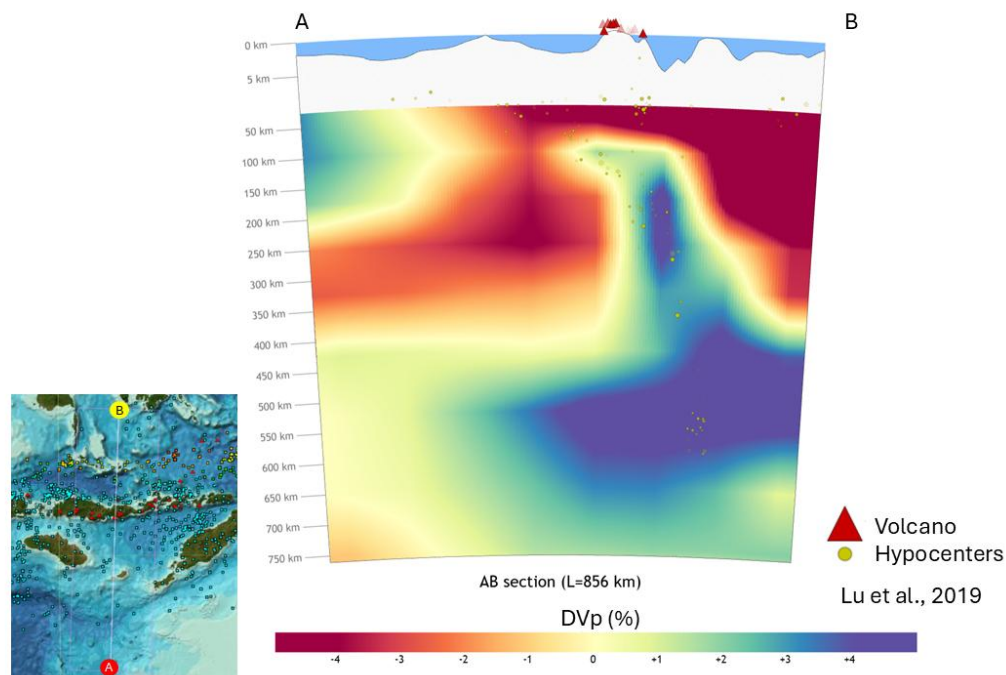


Figure 3. Tomographic sections along the A-B slice through the 7.7 Mw Flores earthquake P-wave tomogram

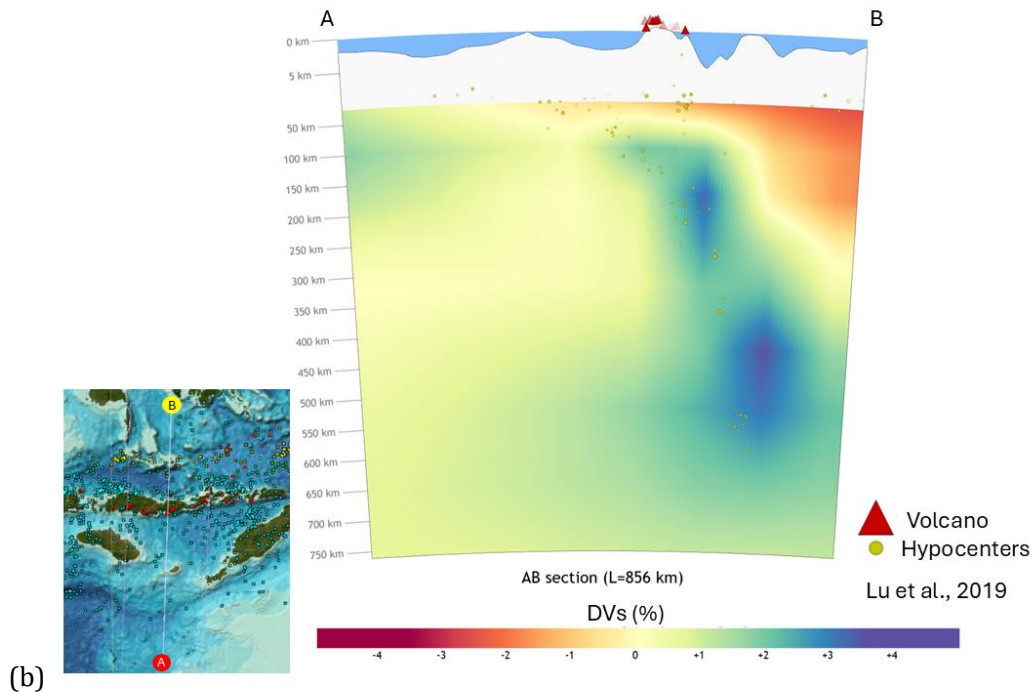


Figure 4. Tomographic sections along the A-B slice through the 7.7 Mw Flores earthquake S-wave tomogram

The Flores Back-Arc Thrust and Seismicity

The hypocenter distribution shows clear clustering in the Flores back-arc region, strongly suggesting active deformation along the Flores Back-Arc Thrust. This pattern is stronger than the expected seismicity along the main subduction zone further south. The 2026 Flores earthquake sequence, with more than 4300 aftershocks, further illustrates concentrated seismic activity at predominantly shallow depths (<60 km).

However, this clear seismicity pattern is not clearly imaged in the V_p or V_s tomographic sections. The tomograms show a broad picture of the region, but the shallow velocity anomaly related to the active back-arc fault is not well defined. Thus, the lack of a clear tomographic anomaly should be understood as a resolution limitation, not as evidence for the absence of an active structure.

Tomographic Resolution and the Need for Further Adaptation

The comparison of V_p , V_s , and hypocenter distributions clearly demonstrates the scale mismatch between the global TX2019slab models and localized seismic structures under Flores. Tectoglob3D gives a good representation of the Sunda–Banda subduction system at the regional scale. However, neither the V_p nor V_s models sufficiently resolve the shallow structure of the Flores Back-Arc Thrust.

The hypocenter distribution, especially the concentration of earthquakes in the back-arc region, is much more pronounced than the corresponding tomographic anomalies. Earthquakes at depths greater than about 40 km are also not consistently reconstructed as coherent structures in the tomograms. These results suggest that the current tomographic representation needs further adaptation for regional and local investigations.

The first step would be to relocate the earthquakes to reduce hypocenter uncertainty and better define seismicity clusters and possible fault geometries. These re-located events can then be used in the local earthquake tomography with an adaptive-grid mesh that has finer cells in areas of

high seismic-ray density and coarser cells in areas of sparse ray coverage.

This approach is supported by the synthetic study of [Ambara Putra et al. \(2024\)](#), which showed the possibility of using an adaptive irregular grid in seismic tomography. Their approach lets the shape and size of tomographic cells vary with the distribution of seismic ray paths, tailoring model parameterization to ray coverage. Synthetic tests show that the adaptive irregular-grid approach improves reconstruction of the target velocity structure compared with conventional regular-grid parameterization.

This approach is especially helpful for the Flores earthquake sequence because the dense aftershock distribution provides dense seismic-ray coverage of the active back-arc region. Thus, an adaptive parameterization would better recover shallow and localized Vp–Vs heterogeneities that current global models poorly resolve, while avoiding overparameterization in poorly sampled regions.

Hence, the limitation identified in Tectoglob3D should not be viewed as a weakness of the platform itself, but as a signal that global-scale tomography requires additional methodological adaptation for localized earthquake-source studies. The Flores earthquake sequence is a suitable dataset for this development, in which earthquake relocation combined with adaptive-grid local tomography provides a route to enhanced three-dimensional imaging of the Flores Back-Arc Thrust.

This study therefore points to the need to transition from global-scale tomographic imaging to a local adaptive tomography framework, where model resolution is explicitly controlled by seismic-ray density and the spatial distribution of relocated earthquakes.

CONCLUSIONS

This study shows that Tectoglob3D, especially the TX2019slab-P and TX2019slab-S models, provides a useful first-order model of the regional seismic structure of the Sunda–Banda Arc down to about 750 km. However, the models do not well resolve the shallow, localized structures related to the Flores Back-Arc Thrust. The 75 km × 75 km × (75–240) km grid employed in TX2019slab is too coarse to capture the structural detail of the back-arc region, including the Flores Back-Arc Thrust.

The hypocenter distribution of the 2026 Mw 7.7 Flores earthquake sequence is clearly concentrated in the back-arc region, more so than the respective Vp and Vs tomographic anomalies. Moreover, the available tomographic models do not consistently image seismicity below ~40 km. Therefore, the issue is the mismatch in scale and resolution between global tomography and localized earthquake structures, not the absence of an active subsurface structure.

Therefore, more detailed tomography is required, and greater attention must be given to grid parameterization in order to improve resolution. Adaptive-grid methods can also be implemented to increase the precision of the subsurface model geometry, as demonstrated in synthetic tests by [Ambara Putra et al. \(2024\)](#). Adaptive parameterization as a function of seismic-ray density should improve imaging of shallow and localized Vp–Vs heterogeneities and better constrain the three-dimensional geometry of the Flores Back-Arc Thrust.

Additional studies should focus on earthquake relocation to decrease hypocenter uncertainty and better constrain seismicity clusters and fault geometries. The relocated earthquake catalog can then be used for adaptive-grid local earthquake tomography, with finer mesh parameterization in regions of high seismic-ray density and coarser cells in regions with limited ray coverage.

This adaptive strategy could improve shallow, localized Vp–Vs heterogeneities. Therefore, we suggest switching from global-scale Tectoglob3D visualization to adaptive local tomography to obtain a higher-resolution three-dimensional image of the Flores Back-Arc Thrust and its relation to the 2026 Mw 7.7 earthquake sequence.

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