Shallow slow earthquake activity in Nankai Trough off Muroto possibly caused by sequential seamount subduction

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Shallow slow earthquakes in the Nankai Trough show a clustered distribution and this has been attributed to different factors such as seamount subduction, pore fluid pressure, fluid migration, and sediment input. However, the mechanism for slow earthquake generation remains unclear. At least four subducted seamounts have been reported off Muroto where slow earthquakes occur. We examined the seismic reflection profiles crossing these seamounts and compared them with sandbox and numerical simulations to infer possible mechanisms for slow earthquake generation. The seamounts are at different stages of subduction and the structural features previously reported in sandbox models such as underplated sediments and suture zones are also recognizable in the reflection profiles. The underplated sediments are interpreted to be comprised of fluid-rich trench fill sediments that were underthrusted together with the seamount. The suture zone separates the accretionary wedge before and after seamount subduction. By comparing with numerical simulations, we propose following upper plate deformation history and mechanism for slow earthquake generation: (1) subduction of the first seamount resulted in the underplating of a large volume of fluid-rich trench fill sediments, (2) the underplated sediments are undergoing horizontal compression from subsequent subduction of the three seamounts resulting in high pore pressure consistent with previously reported low velocity zones, and (3) the horizontal compression may also result in fluid expulsion and these fluids migrate updip and get trapped because the mudstones serve as an impermeable cap. Our proposed mechanism highlights the role of sequential seamount subduction and accounts all the aforementioned factors associated with slow earthquakes, which is not commonly discussed in previous studies, to explain the slow earthquake cluster off Muroto.

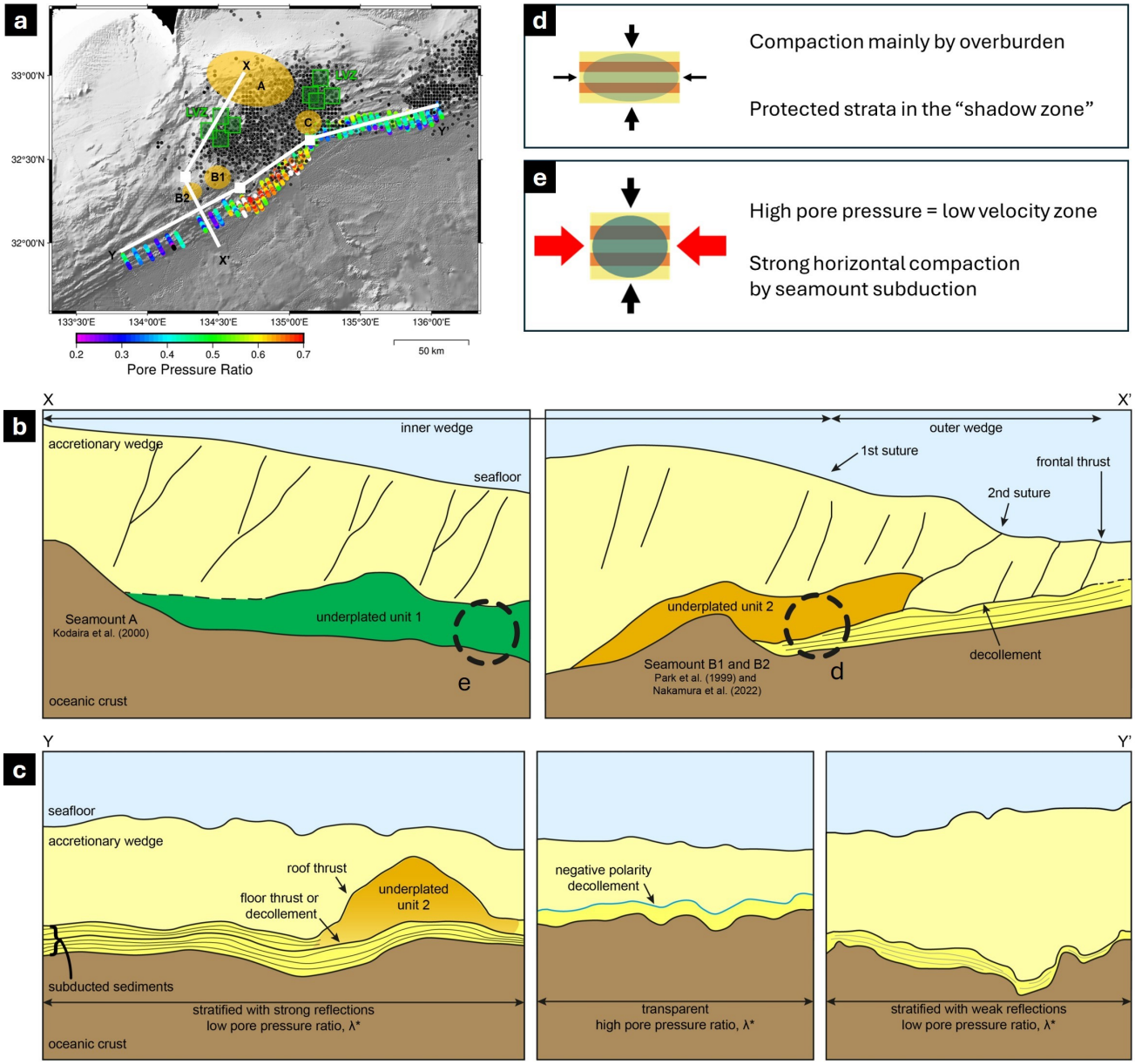

Figure 1. (a) Pore pressure ratio calculated by Flores et al. (2024) using p-wave velocity. Green boxes are low velocity zones identified by Tonegawa et al. (2017). (b) Cartoon cross section of line X-X' showing the deformation caused by the sequential subduction of seamounts A, B1, and B2 inferred from the reflection profiles. (c) Simplified cross section of the along-trough profiles showing the change in the reflection characteristics of the subducted or underthrusted sediments. Gaps in the cartoon sections indicate the kink of the cross sectional lines. (d,e) Schematic illustrations of the mechanical and hydrological conditions of the underthrusted sediments according to Miyakawa et al. (2022).