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Crustal Structure Beneath the Cameroon Volcanic Line and Surrounding Area: Insights from Markov Chain Monte Carlo and Evolutionary Algorithm Based Shear Wave Velocity Inversion

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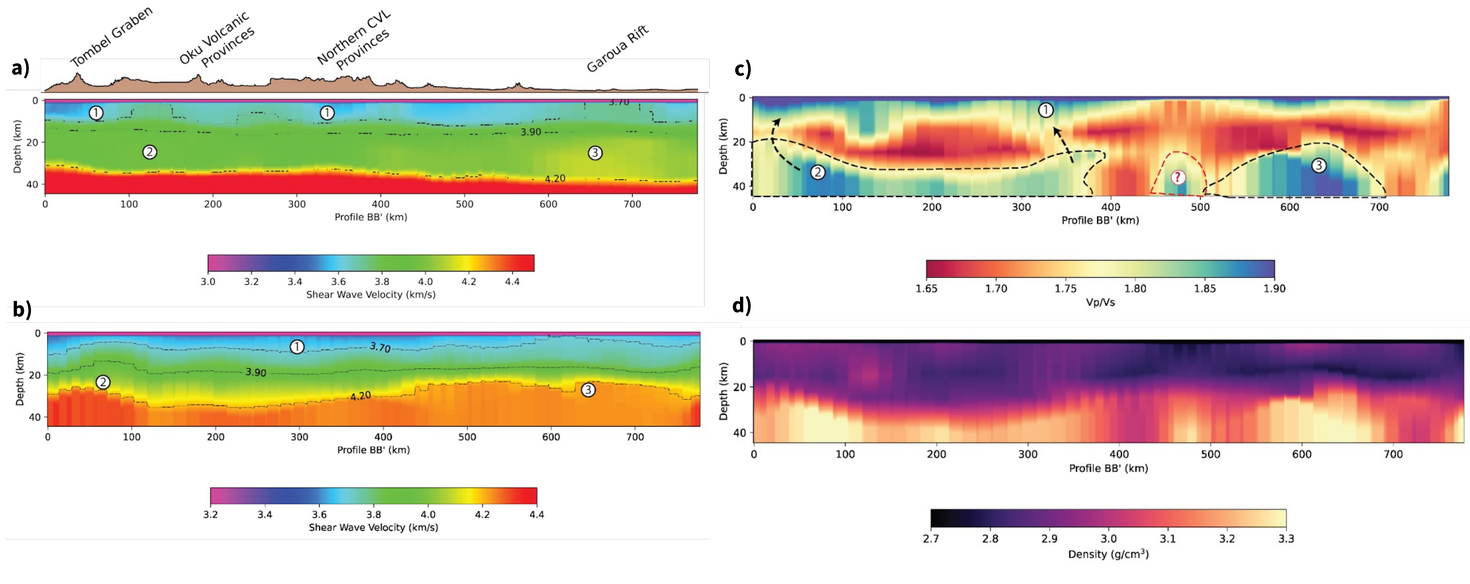
Highlights

- Applied Competitive Particle Swarm Optimization (CPSO) inversion of shear wave velocity and Vp/Vs inversion with ambient noise tomography.
- We identified a high-velocity structure with high Vp/Vs value beneath the Cameroon Volcanic Line (CVL) at 25-35 km depths, suggesting cooled mafic intrusions.
- Cooled mafic intrusions are spatially separated from the upper crust's volcano-plutonic structure by a thin low Vp/Vs structure is metamorphosed granulitic crust formed during Pan African Orogeny and was later thinned by the Mesozoic rifting
- Lateral variation in thickness and physical properties of crust played a crucial role in the distribution of magmatism along the CVL.

Graphical Abstract

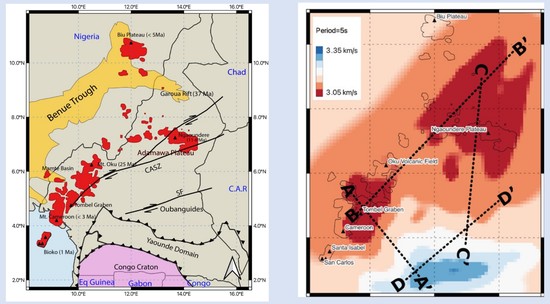


A depth cross section along the CVL

a) Shear wave velocity inversion using MCMC.
b) Shear wave velocity inversion using CPSO.
c) Vp/Vs values obtained through CPSO inversion.
d) Density estimates.

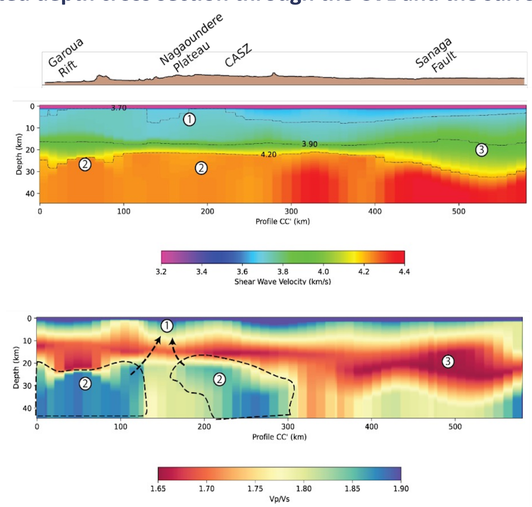
Label 1 marks a low-velocity zone beneath the volcanic provinces characterized by a high Vp/Vs ratio which may be **potential source for magmatism**. Notably, the high-velocity zone marked by **label 2** is situated beneath the CVL, reaching as close as 10 km to the surface at certain places. These high-velocity zones suggest a mafic nature, **potentially indicative of cooled mafic intrusions**. Additionally, observe the **thinner mid-crustal regions** with low Vp/Vs ratios, particularly at locations of recent volcanic eruptions. It is postulated that these regions represent **thinned metamorphosed granulitic crust**. These observations suggest that recent magmatic activities may have originated from areas of crustal weakening and thinning, allowing magmatic material to ascend to the surface through the propagation of deformed zones within the Pan-African Belt (PAB) crust.

Major Geological Features in Cameroon (Left) and corresponding Ambient Noise Tomography (Right).

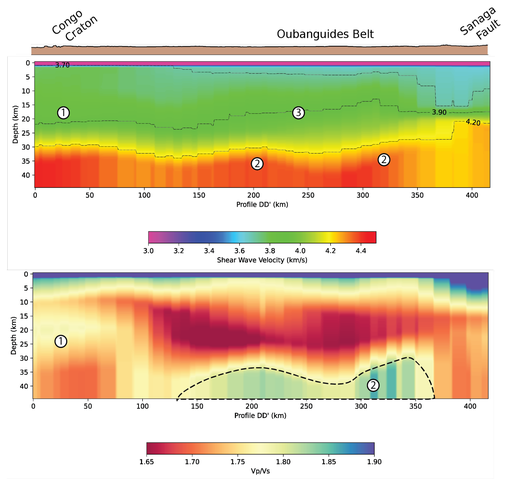


Ages of recent magmatism, do not display the typical age progression associated with the hotspot hypothesis

Inverted depth cross section through the CVL and the surrounding areas



The presence of a slow-velocity structure in the northeastern part of the CVL, indicated by Label 1. Label 2 highlights a high-velocity crustal intrusion beneath the volcanic region. Label 3 may be a thick mid-crustal structure within the Central African Shear Zone (CASZ). It's noteworthy that these structures become thinner as they approach the CVL.



Label 1 highlights the gradual increase in velocity, from 3.7 km/s in the upper crust to over 4.0 km/s in the lower crust, characteristic of cratonic regions worldwide. Label 3 points to the presence of a thick, deformed PAB crust, characterized by slightly higher velocity and a low Vp/Vs ratio. This may be attributed to metamorphosed granulitic crust. Label 2 identifies a high velocity underplating structure beneath the PAB, a feature commonly observed beneath various Proterozoic terrains.