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Seismic Imaging, Arc Magamtism and Megathrust Earthquake under the Western Pacific Subduction Zone

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Arc magmatism and megathrust earthquake occurrence in a subduction zone are deemed to attribute to many factors, including structural heterogeneities, fluid contents, temperature, depth of subducting oceanic crust, and etc. However, how these factors affect them is unclear. The extensive arc magmatism observed on the island arcs is considered to be an indicator on chemical exchange between the wedge mantle and the surface in a subduction zone. Megathrust earthquake frequently occurrence is also considered to be attributed to the slab melting and associated interplate coupling of the subducting plate. The Western Pacific subduction zone is regarded as one of the best Laboratory for seismologists to examine these processes due to the densest seismic networks recording numerous earthquakes. Some of the previous studies suggest that the island-arc magmatism is mainly contributed to the melting of peridotite in the mantle wedge due to fluids intrusion from the dehydration process associated with the subducting oceanic crust. They further argued that the oceanic plate could only provide water to the overlying mantle wedge for arc magmatism, but not melt itself due to that it is too cold to melt at a depth between 100 and 200km. However, some of other studies revealed that the hydrated basalt derived from the mid-ocean ridge will be melted with high T and water saturated on the upper interface of the sbuducting plate in the mantle wedge. We consider that the three-dimensional (3-D) P- and S- wave velocity (Vp, Vs) and Poisson's ratio (σ) structures of the subduction zone, synthesized from a large-quantity of high-quality direct P-, and S-wave arrival times of source-recive pairs from the well located suboceanic events with sP depth phase data could provide a compelling evidence for structural heterogeneity, highly hydrated and serpentinized forearc mantle and dehydrated fluids in the subduction zones. In this study, we combined seismic velocities and Poisson's ratio images under the entire-arc region of the Western Pacific subduction zone to reveal their effects on megathrust earthquake generation and arc magmatism. We find that a ~10 km-thick low-velocity layer with high-V and high-Poisson's ratio anomalies is clearly imaged along the upper interface of the subducting Pacific slab. This distinct layer implies partial melting of the oceanic crust due to the deep-seated metamorophic reactions depending on the source of fluids and temperature regime. Such a process could refertilize the overlying mantle wedge and enrich the peridotite sources of basalts under the island arc. Significant low-V and high-Poisson's ratio anomalies were observed in the mantle wedge along the volcanic front, indicating melting or partial melting of peridotite-rich mantle and then yield tholeiitic magma there. The

present study demonstrates that the combined factors of fluid content, mineral composition and thermal regime play a crucial role in both slab melting and arc-magmatism under the Western Pacific subduction zone.