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Three-dimensional structure and seismicity beneath the Central Vanuatu subduction zone

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The 1400-km long Vanuatu subduction zone results from subduction of the oceanic Australian plate (OAP) beneath the North-Fijian microplate (NFM). Seismic and volcanic activity are both high, and several morphologic features enter into subduction, affecting seismicity and probably plate coupling. The Entrecasteaux Ridge, West-Torres plateau, and Bougainville seamount currently enter into subduction below the large forearc islands of Santo and Malekula. This collision coincides with a strongly decreased local convergence velocity rate – 35 mm/yr compared to 120-160 mm/yr to the north and south – and significant uplift on the overriding plate, indicating a high degree of deformation. The close proximity of large uplifted forearc islands to the trench provides excellent coverage of the megathrust seismogenic zone for a seismological study.

We used 10 months of seismological data collected using the 30-instrument land and sea ARC-VANUATU seismology network to construct a 3D velocity model — using the LOTOS joint location/model inversion software — and locate 11655 earthquakes using the NonLinLoc software suite. The 3-D model reveals low P and S velocities in the first tens of kilometers beneath both islands, probably due to water infiltration in the heavily faulted upper plate. The model also suggests the presence of a subducted seamount beneath south Santo. The earthquake locations reveal a complex interaction of faults and stress zones related to high and highly variable deformation. Both brittle deformation and the seismogenic zone depth limits vary along-slab and earthquake clusters are identified beneath central and south Santo, at about 10-30 km of depth, and southwest of Malekula island between 10-20 km depth.