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A journey to the seismic low velocity zone beneath the ocean (Beno Gutenberg Medal Lecture)

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The seismic low velocity zone (LVZ), first proposed by Beno Gutenberg, is an enigmatic layer of the Earth that has been drawing attention of earth scientists, most-likely because of its close association with the asthenosphere that enables plate motions in the plate tectonics context. “A journey to the LVZ”, therefore, is equivalent to a journey to elucidate the lithosphere-asthenosphere system (LAS) beneath the ocean (at least that is what I mean by this title). Plate tectonics started as a theory of ocean basins nearly 50 years ago, but the mechanical details of how it works are still highly debated. It has been hampered partly by our inability to characterize the physical properties of the LAS beneath the ocean. I will discuss existing observational constraints, including our own results, on the physical properties of the LAS for normal oceanic regions, where plate tectonics is expected to present its simplest form. While a growing number of seismic data on land have provided remarkable advances in large scale pictures, seafloor observations have been shedding new light on the essential details. Particularly, recent advances in ocean bottom broadband seismometry, together with advances in the seismic analysis methodology, have now enabled us to resolve the regional 1-D structure of the entire LAS, from the surface to a depth of $\sim$200km, including seismic anisotropy (azimuthal), with deployments of $\sim$15 broadband ocean bottom seismometers for 1$\sim$2 years. We have thus succeeded to model the entire oceanic LAS without a priori assumption for the shallow-most structure, the assumption often made for the global surface wave tomography. I hope to convince the audience that we are now at an exciting stage that a large-scale array experiment in the ocean (e.g., Pacific Array: http://eri-ndc.eri.u-tokyo.ac.jp/PacificArray/) is becoming approachable to elucidate the enigma of the LVZ, thus the lithosphere-asthenosphere system, beneath the ocean.