The Hawaiian SWELL experiment: An example for the need of Broad-Band Ocean Bottom Seismograms

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Until recently, seismic tomographic studies of the Hawaiian plume have been restricted to using land-based recordings. The limits of such studies is obvious: all of them have a data coverage inadequate to image the proposed plume conduit and details of the seismic structure around Hawaii on scale-lengths less than several 100 km. It is hence not too surprising that not even the location of the plume conduit is known to this date.

Several years ago, we proposed a "PASSCAL experiment in the Ocean", a regional surface wave study using ocean bottom instruments. In 1997, we received NSF funding for a proof-of-concept pilot experiment to the southwest of the Hawaiian Islands. The experiment took place between April 1997 and May 1998 and overlapped with the OSN1 borehole pilot experiment. We used the SIO L-CHEAPO dataloggers (Low-Cost Hardware for Earth Applications and Physical Oceanography) with differential pressure sensors. Such instruments enable us to record teleseismic intermediate-period Rayleigh waves between 15 and 70s. First results presented at various meetings and publications document the success of our experiment with which we were able to image the seismic heterogeneity at the edge of the Hawaiian Swell. Our analysis now includes azimuthal anisotropy. We detect lateral changes in anisotropy for both its magnitude (which is 1.5% on average) and in the direction of fast velocity. The latter changes particularly at longer periods which are more sensitive to mantle flow in the asthenosphere. Away from the islands, our data are well-fit by a standard two-layer in which this flow follows the present-day plate motion and the fossil mantle flow is 'frozen' into the lithosphere. The data closer to the islands require a rearrangement of the flow in the asthenosphere.

The results of this experiment demonstrate that the time is ripe to extend passive regional seismic experiments into the oceans. The data collected at the SWELL pilot array also improve the resolution outside of the array which is demonstrated by including these data in our existing global phase dataset. We further present the great potential of improving the resolution in the oceans by similar passive seismic experiments or proposed permanent stations of the OSN by performing realistic resolution tests in which we adopt the measurement errors gathered at already existing island stations and OSN1.