Mantle Flow from Local S Shear Wave Splitting Across the Mariana Subduction System

Award: 00-01938 (October 2001)

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We analyse the shear wave splitting of local S phases across the western Pacific Mariana subduction system using data from the 2003-2004 Mariana Subduction Factory Imaging Experiment recorded on 20 broadband land seismographs and 58 ocean-bottom seismographs (OBSs) in addition to 9 OBSs from an earlier OBS deployment. We use both the cross-correlation and minimum eigenvalue methods to obtain stable and consistent shear wave splitting patterns throughout the forearc, arc, and backarc system. Results show:

- Arc-parallel shear wave splitting fast directions are recorded at northern latitudes (Agrihan, Pagan, etc) for waves sampling the forearc and beneath the arc including up to the backarc spreading center. Results are sub-parallel to the strike of the arc at mid-latitude stations (Anatahan, etc), the northernmost-southern stations (Saipan, Tinian, etc), and in the southernmost region of our study area (south of Guam).
- Fast directions are parallel or sub-parallel to absolute plate motion (APM) for deep events (hypocenters >250 km depth) in the northern region, for paths recorded at stations on the far side of the backarc spreading center, and immediately surrounding the southernmost island (Guam). These results suggest that the typical interpretation of mantle flow strongly coupled to the downgoing slab (producing APM-parallel fast directions) is only valid at depths greater than ~250 km and at large distances (>~250 km) from the trench. We hypothesize that the observed dominance of arc-parallel fast directions is probably the result of physical arc-parallel flow, which may result from along-strike pressure gradients in the mantle wedge, possibly due to changes in slab dip or other tectonic features.

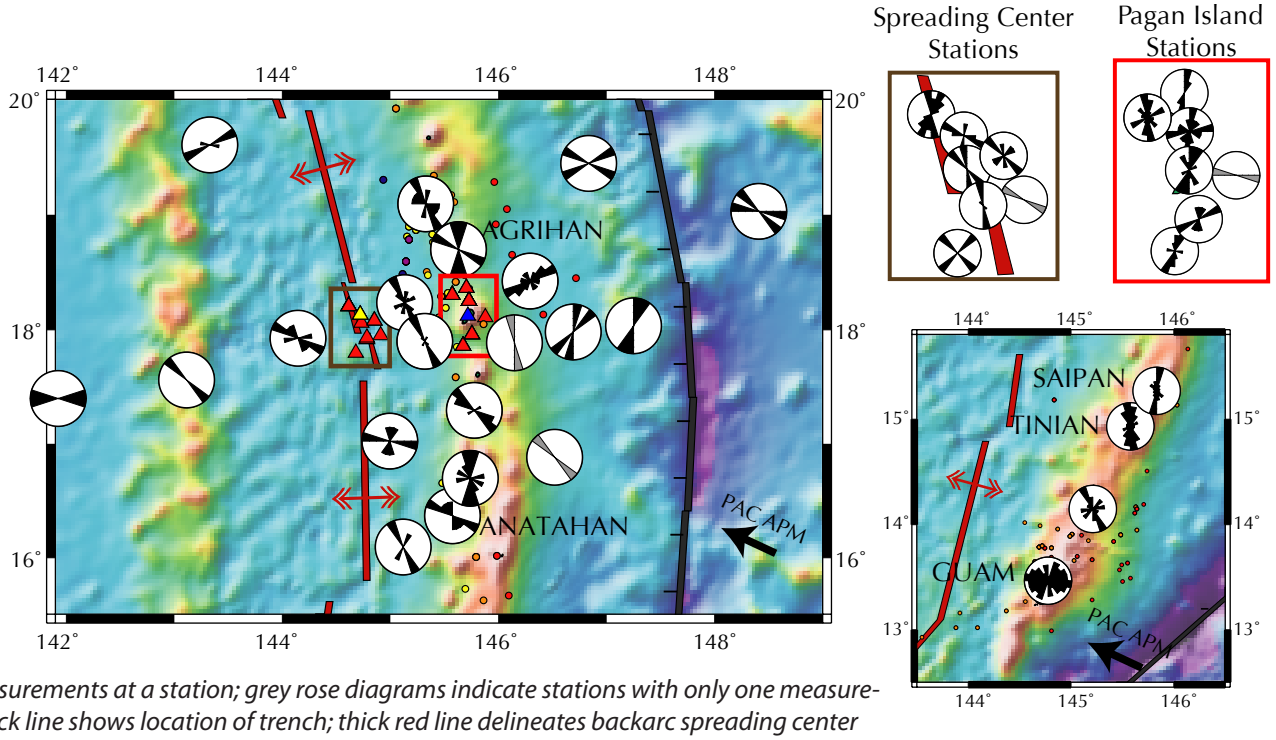

Figure: Shear wave splitting fast directions plotted in rose diagrams for each station atop color bathymetry [Pozgay et al., GJI, 2007]. Dense station clusters are shown in inset. Measurements are plotted in azimuthal bins of 15deg. Black rose diagrams include up to nearly 100 measurements at a station; grey rose diagrams indicate stations with only one measurement. Thick black line shows location of trench; thick red line delineates backarc spreading center with arrows showing direction of spreading; Pacific Plate APM arrow in bottom right.

Pozgay, S. H., D. A. Wiens, H. Shiobara, and H. Sugioka (2007), Complex Mantle Flow in the Mariana Subduction System: Evidence from Shear Wave Splitting, Geophysical Journal International, v. 170, p. 371-386, doi:10.1111/j.1365-246X.2007.03433.x.