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Award Abstract #0549056

MARGINS: Dynamics of the Mariana Subduction Factory Determined From Seismic Observations and Geodynamic Modeling

NSF Org:	EAR
Initial Amendment Date:	March 3, 2006
Latest Amendment Date:	March 3, 2006
Award Number:	0549056
Award Instrument:	Standard Grant
Program Manager:	William P. Leeman EAR Division of Earth Sciences GEO Directorate for Geosciences
Start Date:	February 15, 2006
Expires:	January 31, 2008 (Estimated)
Awarded Amount to Date:	$201579
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Sponsor:	Washington University ONE BROOKINGS DRIVE, CAMPUS BOX SAINT LOUIS, MO 63130 314/889-5100
NSF Program(s):	PETROLOGY AND GEOCHEMISTRY
Field Application(s):	0000099 Other Applications NEC
Program Reference Code(s):	OTHR,0000
Program Element Code(s):	1573

ABSTRACT

This study will integrate seismological observations with geodynamic modeling to understand processes of mantle flow, magma production, and fluid and magma transport in the mantle wedge below the Mariana subduction zone. The following questions will be addressed: 1. Are the Mariana geophysical observations well fit by a simple 2-D counterflow model of

mantle flow or do they require a more complex 3-D pattern? What is the role of mantle flow in controlling the magma production regions for the arc and backarc? Is the seismic anisotropy pattern consistent with lattice-preferred-orientation (LPO) of minerals in the orientation of maximum extension or is the pattern suggestive of LPO rotation because of the presence of water? 2. What are the distribution of temperature anomalies, fluids, and melt in the upper mantle beneath the Mariana arc? What is the temperature structure of the Mariana arc and how is it related to mantle flow and island arc magmatism? What is the degree of spatial interaction at depth between arc and backarc magma production regions. Work already performed with an existing grant, including earthquake location, shear wave splitting analysis and body wave tomography will be extended to include: 1. Development of a 3-D attenuation tomographic model, which is essential for interpreting seismic data in terms of temperature, melt and other physical parameters. 2. Use of newly developed noise correlation techniques to obtain Rayleigh wave Green's functions (including data from a short-term OBS layout even though that array failed after 50 days). 3. Inversion of body and surface wave data to obtain a single well-constrained tomographic image. Predictions of thermal structure, flow field and expected melt generation regions from geodynamic modeling will be tested directly against the seismic observations using laboratory relationships relating seismological results to the temperature, melt, and water content of the mantle wedge. A large Japan-US Margins-funded EM study in 2006 provides constraints on the conductivity structure of the mantle will also be used to further constrain the physical processes occurring in the Marianas mantle wedge. Strain development will be tracked through the flow models from which predicted shear wave splitting from synthetic seismic rays through the model space can be compared with the observed pattern. Both the seismological and geodynamic modeling will be done by the PI's group, thus ensuring considerable feedback between these efforts. Broader Impacts: This proposal will support a Ph.D. student who will most likely be female. The PI (Wiens) has a strong record of mentoring graduate students, and has graduated 5 Ph.D. students (3 male and 2 female) in the last 11 years. This research will also help further the career and provide continuing support for Research Scientist James Conder. This work will result in the development of new seismological and geodynamical analysis routines, which will be made available to the community. The resulting P, S, and Q tomographic models as well as the 3-D thermal fields and associated streamlines available to the community through the MARGINS website for use by other investigators.

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Last Updated:Feb 10, 2006