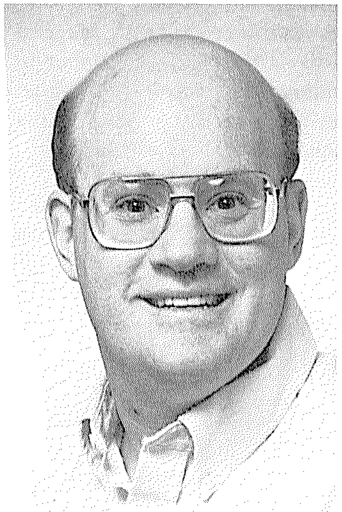
The James B. Macelwane Medal

Seth A. Stein

For significant contributions to the geophysical sciences by a young scientist of outstanding ability



It is a great pleasure for me to introduce my colleague Seth A. Stein, as one of this year's winners of the Macelwane Medal. Seth is a dynamic personality who, in the matter of a few years, has managed to kill quite a number of sacred cows with the clarity of his insight and, in some cases, the strength of his oratory. He is widely recognized as a leader in using earthquake seismology to investigate plate tectonic processes. His work is distinguished by the creation of useful, testable models and a rare balance between careful analysis of data and insight into the physics of geological processes.

As a graduate student at Caltech, Seth and fellow student Emile Okal investigated the concentrations of large (M>7) "intraplate" earthquakes in the Central Indian Ocean. They showed that most of these earthquakes occurred near and along the so-called "aseismic" Ninetyeast Ridge, with focal mechanisms indicating -1 cm/yr strike-slip motion along the ridge and N-4S compressions west of it. They attributed deformation to the Himalayan collision and produced a model which was later verified from marine geophysical and satellite altimetric data. Seth also identified a similar, though less intense concentration of intraplate earthquakes on the "aseismic" Chagos-Laccadive Ridge to the west. These observations motivated suggestions of nonclosure of the Indian Ocean triple junction, suggestions which he, Douglas Wiens, Richard Gordon, and graduate students at Northwestern have developed and extended into a new plate geometry model for the Indian Ocean region.

Since joining the faculty at Northwestern (1979), Seth has distinguished himself by the breadth of his interests, his ability to work with a large number of colleagues, and by the enthusiasm with which he attracts and stimulates graduate students. In the latter context, his best-known work is perhaps that with Douglas Wiens which showed that the maximum depth of oceanic intraplate earthquakes, and hence the portion of the plate rigid enough for faulting, increases with age in agreement with thermal models. The temperatures as a function of depth and plate age and laboratory rock mechanics data successfully predict the depth of faulting, constrain lithospheric rheology and explain important aspects of the dynamics of transforms and subduction zones. They also showed that, for lithospheric ages less that 20Ma, focal mechanisms indicate ridge-parallel instead of ridge-normal extension, thus disproving the generally held idea of a zone of distributed extension and suggesting that the ridge axis itself is rheologically weak. With Joseph Engeln, Seth developed a model based on earthquake mechanisms at the Easter microplate to explain how spreading center reorganizations occur by rigid microplate evolution. The model predicts a characteristic kinematic history of rotations, shown by magneticanomaly data, which they and others have identified in other microplates both presently active and in the geologic record. Their work shows that the powerful tools of rigid plate tectonics can be usefully extended to plates that are very small indeed.

Although it is hard to summarize a large body of work adequately, there are one or two other studies which I can use to illustrate Seth's breadth of interests and originality. He has made, for example, some important contributions to understanding the enigmatic Caribbean plate. A study of post-1915 earthquakes in the Lesser Antilles arc showed that seismicity is dominated not by interplate thrusting, as expected from conventional plate tectonic models, but by intraplate normal faulting, suggesting that plate convergence is nearly aseismic. The study also showed that the intraplate seismicity is affected by the subduction of bathymetric highs and that the mechanism data show no evidence of the North America-South America-Caribbean triple junction. In an elegant display of the power of relative plate motion analysis, Seth, Richard Gordon, and a group of students were able to resolve a major controversy between two distinct models which have been proposed for the relative motions between the Caribbean and neighboring plates. More recently, Seth's work on subduction zones has led him, in conjunction with students George Helffrich and John Brodholt, to look at the thermal structure and petrology of subducting lithosphere in an attempt to understand the distribution of seismicity and the observations of seismic wave conversions and reflections near the slab-mantle interface. With Wim Spakman he has been investigating the real resolution of seismic tomographic images of subducting slabs and has shown, using synthetic data, that it is possible to generate apparent structures, such as "fingering" of the slab along the 670 km discontinuity purely as artifacts of ray geometry. This result has obvious and major implications for some recently proposed models of slab geometry and the coupling between upper and lower mantle convection.

That is a brief sketch of some of Seth's achievements. It doesn't really indicate, however, quite how stimulating he is to have around, nor what a good teacher he is, nor how much support and help he gives to his students and colleagues, nor how much time and effort he puts into duties for the AGU and his department. Now that he's departmental chairman he might slow down a bit and worry more, but at least we won't be able to notice the gray hair! I am indeed honored and delighted to introduce Seth Stein, a scientist of whom the AGU can be proud.

Bernard J. Wood