Summary. In the last decade, considerable effort has been devoted to developing tomographic images of the seismic structure of mid-ocean ridges and hot spot volcanoes. These images have provided a wealth of information about the distribution of magma, and have resolved several important issues concerning the role of these features in tectonics, crustal genesis, etc. Nevertheless, the models have for the most part been put to descriptive and qualitative uses. Their application to quantitative models of geophysical phenomenon have been fairly limited, which is ironic given that they provide a very quantitative and detailed description of the subsurface. Here we propose to use a particular tomorgaphic model - one that includes Axial volcano and nearby portions of the Juan de Fuca Ridge - to develop quantitative 3D models of stress and deformation in this region. We will compare the predictions of these models with geodetic, tidal-loading and seismicity data, and use them to attempt to explain some puzzling features of these data.

The new tomographic model was constructed using data from a 1998 airgun-to-OBS active imaging experiment. The imaged area includes a 40 by 40 km region around Axial volcano, and includes both the central Axial magma chamber and a smaller, apparently unconnected magma chamber on the Coaxial segment of the Juan de Fuca region. The model also includes variations in Moho depth, which are quite strong, with the Moho deepening to about 11 km beneath the center of the volcano (from about 8 km at its flanks). We plan to convert this compressional velocity model to 3D stress/deformation models. Three phases of modeling are envisioned, a control phases using simple a simple Mogi-type description of pressure sources; a fully threedimensional quasi-static elastic model that can address the way in which lateral heterogeneities (and especially the irregularly-shaped magma chamber itself) concentrate stres; and finally, a fully three dimesional model that also includes viscoelastic creep. The elastic model will use the inexpensive and commercially-available BEASY boundary-element method code. The viscoelastic calculations will employ Jishu Deng's FEVER finite element code.

A systematic analysis of uncertainty will be an integral part of the study. As we represent the earth with increasingly complex models, we need to be increasingly cognizant, first of the potential sources of uncertainty in these models and second, of the ways in which these uncertaintainties interact and lead to errors in predictions of the geophysical observables. Uncertainties arise because of noise and poor resolution in the underlying tomographic model; in the way in which seismic velocity is scaled into elastic and viscoelastic parameters, and in the way the three dimensional models are regridded in order to meet the demands of particular software packages. We will employ a standard Monte Carlo approach to quantifying the next effect of all these uncertainties.

A fairly large and diverse body of geophysical data are available for Axial volcano and its environs, collected during a decade-long interval that includes two major volcanic eruptions. These measurements include extensometer, tilt, and subsidence measurements made with ocean bottom sensors deploy around the volcano, seismicity measurements made with SOSUS and with OBS's, and heat flux estimates made by tracking thermal plumes emanating from hydothermal fields. Each of these measurements has features that are currently unexplained, but which may be related to the effect of magma, and the very large lateral gradients in material properties and temperature that it causes.