Journal of Conference Abstracts
Volume 7(2), 141

Sub-basalt imaging using seafloor compliance: a case study

WAYNE C. CRAWFORD (crawford@ipgp.jussieu.fr)

LITHOS group, IPG Paris, 4 Place Jussieu, 75252 Paris Cedex 05, France

Seafloor compliance

Seafloor compliance is the deformation of the seafloor under very long period (20 seconds to 20 minutes) ocean waves (Crawford et al., 1998). Compliance as a function of frequency depends on the shear modulus as a function of depth beneath the measurement site: compliance is largest over regions of low shear modulus and the compliance is sensitive to deeper structure as the frequency decreases. The sensitive depths of compliance depends on the water depth, ranging from 0.04-2.2 km at 0.2 km water depth and from 0.4-7 km at 2 km depth.

Compliance measurements may be well adapted to detecting and constraining sub-basalt reservoirs. The measurements have proven particularly sensitive to fluid-bearing regions. To date, compliance experiments have focused on studies of melt and hydrothermal circulation in seafloor volcanic systems, but the technique should be sensitive to sub-basalt reservoirs because of its sensitivity to low shear modulus and because it is a quasi-static measurement and therefore unaffected by reflective boundaries within the overlying basalts. Compliance is measured using a 2 day deployment of a broadband seismometer and differential pressure gauge on the seafloor. Since only a few measurements may be sufficient to determine the existence and to constrain the thickness of a sub-basalt reservoir, the technique can be relatively inexpensive.

The study

We investigated the sensitivity of compliance measurements to sub-basalt reservoirs as a function of the reservoir size, reservoir shear modulus, water depth, source wave height and surface sedimentation. We test the sensitivity of compliance to sub-basalt reservoirs by running minimum structure and Bayesian inversions on simulated compliance measurements. We used a one-dimensional sub-basalt sediment model beneath 2 km of water (table 1).

	thickness (km)	density (g/cc)	Vp (km/s)	Vs (km/s)
sed0	0.05	1.5	1.7	0.2
sed1	1.5	2.0	1.7	0.7
basalt	2.0	2.45	4.7	2.7
sub-basalt	variable	2.35	3.6	2.1
basement1	2.0	2.65	5.7	3.35
basement2	infinite	2.65	6.2	3.5

Table 1: sub-basalt reservoir model

A critical part of the simulation is the calculation of data uncertainty levels. We have developed an algorithm to calculate data uncertainties using the source wave energy, the basement structure and typical seismic and pressure noise levels. The algorithm matches measured uncertainty levels well.

Results

Inversions of the simulated measurements reveal that compliance measurements can detect a 2 km tall sub-basalt reservoir if the source wave energy is the minimum expected in an ocean, and can detect smaller reservoirs if the waves are larger. For a Bayesian inversion in which the distance to the top of the basalts is well-constrained by seismic measurements, the depth to the top of the reservoir and the thickness of the reservoir can be estimated to within 0.5 km.

References

Crawford, W.C., Webb, S.C. and Hildebrand, J.A. , 1998. Estimating shear velocities in the oceanic crust from compliance measurements by two-dimensional finite difference modelling, *Journal of Geophysical Research*, **103(5)**, 9895 - 9916.