Seismic anisotropy changes across upper mantle phase transitions

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Constraining mantle flow near the mantle transition zone (MTZ) can help better understand its role in Earth's thermochemical evolution and mantle dynamics. Using a higher mode surface wave seismic dataset [1] we modeled global 3-D azimuthal anisotropy in the top 1000km of the mantle, thereby providing constraints on mantle deformation to much greater depths than in previous studies.

Our model unravels significant seismic anisotropy in the MTZ, challenging common views of mantle deformation, and reveals a striking correlation between minima in anisotropy amplitudes, changes in the fast axes of propagation, and the location of phase transitions. This relation between anisotropy changes and phase transformations suggests lattice preferred orientation of anisotropic material in the deep upper mantle.

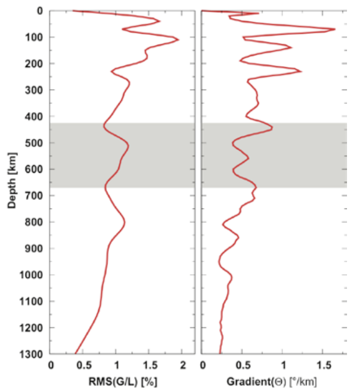

Figure 1**: Root mean square anisotropy amplitude (left) and average vertical gradient of fast axis (right)**

The detected global changes in the fast axes could indicate mantle flow layering, consistent with mantle geochemistry. The interpretation of our results in terms of convection style and therefore in terms of heat transport is however non-unique due to a lack of laboratory data on MTZ mantle anisotropy. Seismic anisotropy might not be a good proxy for mantle flow at these depths, in which case whole mantle convection cannot be ruled out.

Nevertheless, our model provides unique new constraints on mantle deformation and advances toward a better understanding of Earth's convective pattern and heat transport will require stronger constraints on the effects of pressure, temperature, melting, and water content on the deformation mechanisms and slip systems of MTZ materials.

[1] Visser *et al*. (2008) *Geophys. J. Int*. **172**, 1016-1032.

Volatile distribution in the Taupo Volcanic Zone, New Zealand

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The central Taupo Volcanic Zone (TVZ) is an actively rifting continental arc where more than 6000 km^3 of rhyolitic magma has erupted from at least eight caldera centres over the past 1.6 Ma. The extensive magmatism in the TVZ is intimately associated with the high heat flux and active geothermal systems. These geothermal systems have previously been subdivided into two groups: 1) low-gas (i.e. CO_2), high Cl, low B and Li/Cs ratio systems suggested to have chemical affinities with basaltic (and rhyolitic) magmas, and 2) high-gas, low Cl, high B and Li/Cs ratio systems having chemical affinities with andesitic magmas.

Here we present new trace and volatile data on quartz-hosted melt inclusions from eight large, rhyolitic eruptions to examine the relationship between slab-derived fluid input and the geographic distribution of the two chemical groups observed in the present-day hydrothermal systems.

Based on trace element and volatile content, the rhyolites can also be subdivided into two distinct groups; R1 which is enriched in Li, Ba and B, and has Cl contents of ~0.2 wt%; and R2, which has lower content of these fluid-mobile elements, but higher Cl contents (0.25 to 0.35 wt%) than R1.

These differences in volatile contents are related to distinct parental magmas (i.e. two distinct sources), with "wetter" R1 having a higher slab-fluid component compared with the "dryer" R2. The difference in chlorine content between R1 and R2 magmas is related to the Cl solubility, which increases with decreasing H_2O content (i.e. higher Cl content in the dryer R2 melts).

A comparison between the new volatile data on the rhyolites and these present-day geothermal systems reveals that the observed differences in the fluid composition of surface springs are correlated with the distribution of the two rhyolite types. We, therefore, suggest that the variation in geothermal fluids does not necessitate a separate andesitic magma as a source, but is a continuation of different slab-derived fluid contributions producing slightly different rhyolite types. While the correlation observed here is strong, we do not rule out the influence of fluid-rock interaction as a possible contributor and this remains to be explored.

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