Lower mantle superdomes and plumes

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Current tomographic models of the Earth display perturbations to a radial stratified reference model. However, if these are chemically dense structures with low Rayleigh numbers, they can develop enormous relief, perhaps with boundaries closer to vertical than radial. Several new methods have been developed to simulate 3D synthetics for such structures. The method we use approximates 3D effects by adding out-of-plane contributions from virtual receivers at neighbouring azimuths with two related to the inner Fresnel zone and two longer-period contributors sampling the outer Fresnel zone. The four responses are scaled by diffraction operators that are defined by the source duration and travel time from the sharp edge structures. Here, we develop a new tool for processing array data based on such a decomposition referred to as a multi-path detector which can be used to distinguish between horizontal structure (in-plane multi-pathing) vs. vertical (out-of-plane multipathing) directly from processing array waveforms. We demonstrate the usefulness of this approach by processing samples of both P and S data from the Kaapvaal Array in South Africa. The strength difference between patterns produced by S vs. P-waves for the same event further validates the nature of these chemical boundaries. A detailed SKS wavefield is assembled for a strip along the southern boundary by combining multiple events from the Kaapvaal Array. Applying this technique to this composite data set, we locate a prominent ultralow velocity zone at the edge of a 1000 km high jagged wall. We present evidence for a narrow plume with a diameter less than 100 km extending upward another 500 km from the top of the dome, in agreement with recent tomographic images and thermo-chemical convection models.

Seasonal variations in $\delta^{13}C$ and $\delta^{18}O$ of travertine

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To understand the oxygen and carbon isotopic compositions of annually banded modern travertine, which is important to the high-resolution paleoclimatic reconstruction with travertine records, organic glass substrates (5cm×5cm×0.5cm) were installed in a travertine-depositing stream at Baishuitai, SW, China and replaced semimonthly. The seasonal and spatial variations of $\delta^{13}C$ and $\delta^{18}O$ of the travertine deposited on the substrates were obtained. Meanwhile, the isotopes of the coeval rainfall were also measured.

A clear linear negative correlation between the isotopes of the travertine and rainfall were obtained. The linear eauation between the $\delta^{13}C$ values and the rainfall amount was $\delta^{13}C$=4.19998-0.00621*rainfall amount (r=0.834), and the linear equation between the $\delta^{18}O$ values and the rainfall was $\delta^{18}O$=-12.13-0.0068*rainfall amount (r=0.66). The results show the feasibility of freshwater travertine to provide valuable infamation on seasonal or even monthly rainfall variations and provide experimental base for paleo-rainfall reconstruction with old travertine.

The low $\delta^{18}O$ values in rainy season are believed to be related to the rainfall amount effect in Asian Monsoon climate, and. the low $\delta^{13}C$ values during the rainy season to the dilution of the overland flow after rainfall in $\delta^{13}C$ of the stream [HCO_3^-], which is related to deep source CO_2 and much higher than that of epikarst water [HCO_3^-],the latter being controlled by biological soil CO_2.