Petrofabrics and seismic properties of garnet amphibolite and implications for a thick amphibolitic lower crust in central Tibet

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Continental lower crust is the bridge between the felsic upper crust and the ultramafic upper mantle and plays a key role in the evolution of the lithosphere. The bulk composition of the continental lower crust is well established and generally believed to be mafic granulite. Whether the lower crust is a mechanically strong or weak layer compared to mantle peridotite and upper crust granitic rocks has been controversial. The Tibetan Plateau, the result of continental collision between the Indian and Eurasian plates since ~50Ma, has a thick (up to 70 km) lower crust. It has been suggested that the crust and mantle parts of the lithosphere flow as a whole while some others interpret the plateau uplift as the consequence of a ductile flow of the lower crust. The latest SKS measurements show a strong and systematic back azimuthal variations of the splitting parameters with a 90° periodicity in central Tibet and splitting times as large as 1.3s, suggesting two strong anisotropy layers corresponding to the lower crust and lithospheric mantle.

Here we report the deformation petrofabric, seismic properties of garnet amphibolites from the exhumed lower crust of Tibet of the eastern Himalayan syntaxis. Our results show a strong fabric of hornblende with [001] forming a well defined point maximum parallel to lineation and [100] and [010] forming girdles normal to the lineation and a weak fabric of garnet. The seismic anisotropies of garnet amphibolites are AVp=12.9%, AVs_1=4.7%, AVs_2=4.6%. They are much more significant than those of deformed mafic granulite and eclogite (thickened lower crust). Our simulation results suggest that a 40 km-thick amphibolitic lower crust can general a splitting time of 0.72s. By comparing to the shear wave splitting parameters and the anisotropy of surface wave in Tibet, we suggest that garnet amphibolites may contribute at least 0.5s splitting time for the SKS measurements in central Tibet and is probably the main cause for the shear wave polarized direction anomalous. An anisotropic amphibolitic lower crust also indicates that the Tibetan lower crust has been strongly plastically sheared.