Deformation and Partial Melting of Himalayan Amphibolites: Implications for a Thick Anisotropic Deep Crust Beneath the Tibetan Plateau

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The Himalayan collision zone, the result of underthrust of the Indian lithosphere below the Eurasian plate since ~50 Ma, provides a natural laboratory for understanding continental dynamics. Channel flow deformation and partial melting within the mid-lower crust of the Tibetan Plateau has continued to receive great attention for the interpretation of crustal thickening, plateau uplift and postcollisional magmatism in the past decades. However, one fundamental problem remain unsolved is what bulk rock composition could best represent the mid-lower crust of the overthickened Tibetan Plateau. Bulk rock composition provides a first-order control on deformation and partial melting in deep crust. The bulk composition of the overthickened Tibetan deep crust has been generally believed to be mafic granulite with eclogite at the lower most crust. Here we present petrofabrics and seismic properties of amphibolites from exhumed crustal part of the India plate in the eastern Himalayan syntaxis. Our results show strong fabrics of amphibole and nearly random fabrics of plagioclase in amphibolites, resulting in strong seismic anisotropies (AVp = 6.7-11.7 % and AVs = 5.7-9.6 %). Comparing to a deep crust composed of nearly isotropic mafic granulite and weakly anisotropic eclogite, a thick amphibolitic deep crust would better account for the 0.2-0.5 s shear wave delay times, the strong Vp and Vs anisotropies and their polarization directions. In addition, partial melting experiments on a garnet amphibolite and the same garnet amphibolite mixed with 20 wt. % of a primitive Tibetan shoshonite demonstrated that all characteristic features of the widespread postcollisional adakite-like rocks can be convincingly reproduced by the hybrid experiments. The input of mantle-derived alkaline melt to a crustal source can provide not only the high concentrations of incompatible elements characteristic of silicic and K_2O-rich adakite-like magmas, but also the heat necessary for crustal melting. A thick anisotropic amphibolitic deep crust would reconcile better the geological and geophysical observations in south and central Tibet.