Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

SCG67-10 Room:201A Time:May 25 11:30-11:45

Paleo shoreline profiles of lake Nam Co and the rheology of the Tibetan mid crust

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A major point of dispute in the tectonics of the Tibetan Plateau is whether the mid crust is weak enough to flow decoupled from the upper crust. Flow of the mid crust over distances of 100s or 1000s kilometers has been proposed and inflow of relatively low viscosity (no more than 10^{19} Pa s) rock from beneath the high plateau into the mid crust of the surrounding lower-lying regions has been proposed as a key process in the lateral growth of the plateau. However, different assumptions about the properties of the crust lead to the opposite conclusion: active deformation of the Plateau is better explained if the mid and upper crust of the plateau deform together and are not decoupled. Paleo lake shorelines offer a way to test these contrasting models and to contribute to our understanding of crustal rheology. Prominent shorelines developed around Lake Nam Co in central Tibet are excellent markers of the paleo horizontal in this region. Real time kinematic GPS surveys of these markers show there is no significant uplift despite a water level drop of several 10s meters. ^{14}C dating of lake tufa deposits shows the the age of a prominent shoreline at 20m above the present lake level to be between 10 and 20 ka. The lack of any isostatic response to water level drop over a time scale of more than 10,000 years implies either a high viscosity mid crust ($>10^{20}$Pa s) or a large elastic thickness to the crust. In either case these results imply that there is no continuous low viscosity mid crustal layer beneath Tibet in this area. We suggest that evidence for partially molten-and hence low viscosity-mid crust only reflects conditions of localized patches of crust. The lack of a continuous weak mid crustal layer argues against large-scale decoupling of the mid and upper crust. This implies that large-scale inflow of mid crustal rocks is unlikely to play a significant role in the expansion of the Tibetan plateau and that the mid crust can sustain significant stresses even on geological time scales.

Keywords: Tibet, Lakes, Mid crust, Rheology, Age