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Metamorphic, thermal, and tectonic evolution for Fe- and Al-rich metapelites of the Panimba shear zone, Yenisey Ridge, Eastern Siberia

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In the Transangarian region of the Yenisey Ridge in Eastern Siberia (Russia), Fe- and Al-rich metapelitic schists of the Korda plate show field and petrological evidence of two superimposed metamorphic events. An early Middle Proterozoic event with age of $c.$1100 Ma produced low-pressure, andalusite-bearing assemblages at about 3.5-4 kbar and 540-560 ˚C. During a subsequent Late Proterozoic event at $c.$850 Ma, a medium-pressure, regional metamorphic overprint produced kyanite-bearing mineral assemblages that replaced minerals formed in the low-pressure event. Based on the results of geothermobarometry and $P-T$ path calculations it can be shown that pressure increased from 4.5 to 6.7 kbar at a relatively constant temperature of 540-600 ˚C towards a major suture zone called the Panimba thrust. In order to produce such nearly isothermal loading of 1 to 7 ˚C/km $^{-1}$, we propose a model for the tectono-metamorphic evolution of the study area based on crustal thickening caused by southwestward thrusting of the 5-7 km-thick upper-plate metacarbonates over lower-plate metapelites with velocity of $\sim$ 350 m/Myr. A small temperature increase (up to 20 $\pm$ 15 ˚C) of the upper part of the underthrusted plate is explained by specific behaviour of steady-state geotherms calculated with using lower radioactive heat production of metacarbonates as compared with metapelites. The suggested thermal-mechanical model corresponds well with $P-T$ paths inferred from obtained thermobarometric data and correlates satisfactorily with $P-T$ trajectories predicted by other two-dimensional thermal models for different crustal thickening and exhumation histories. It also explains the $P-T$ history and other metamorphic features (e.g. the gradual change in recorded pressure between low- and medium-pressure rocks; small temperature increase; kyanite

pseudomorphs after andalusite porphyroblasts; common increase in garnet grossular content from core to rim) associated with this tectonic phenomenon and confirms the possibility of prograde transformation of andalusite to kyanite during overthrusting. Thermodynamic analysis shows that the very large volume ($-\Delta V$=42-49%) and small entropy effects characterize the calculated reactions, which form pseudomorphs and minerals in the adjacent matrix. It indicates that the prograde evolution of chemical and modal compositions of minerals during metamorphism was controlled by gradual pressure increase (at nearly constant temperature) accompanied by deformation within the bulk composition of the protolith.