# Thermal modelling of metamorphism and exhumation in Western Nepal and India

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The geological association of the Himalayan range is a juxtaposition of inverted metamorphic sequences in the footwall of the Main Central Trust (MCT) with a belt of Miocene leucogranites emplaced above the fault (Figure 1). The MCT extends across the 2500 km length of the Himalayan orogen and is the dominant structural feature of that mountain belt.

The inverted metamorphic sequences beneath the MCT ramp has been interpreted as a reactivation of the thrust following ~10 m.y. of inactivity [e.g. Harrison et al 1997]. Measured monazite ages from the lower Lesser have been used to interpret reactivation of the MCT at ca. 8 Ma and activation of the MCT Zone at ~6 Ma. More recently, Bollinger et al 2004 and 2006 showed that shortening across the Himalaya can be explained by accommodation by a single fault, the Main Himalayan Thrust (MHT), and that the growth of Himalayan wedge has resulted from underplating and development of a duplex. In this latter scenario, the MCT zone corresponds to the MHT exhumed at the surface.

In both instances, an increase of exhumation from about 8 Ma is required. We test here these models in Far West Nepal and India, where new thermochronological data have been collected (Ar39/Ar40 in muscovite, Raman Spectrometry and (U-Th)/He in zircon). We use a thermal-kinematic model which solves the heat transfer equation coupled with an inversion algorithm, the Neighbourhood Algorithm (Sambridge 1999).

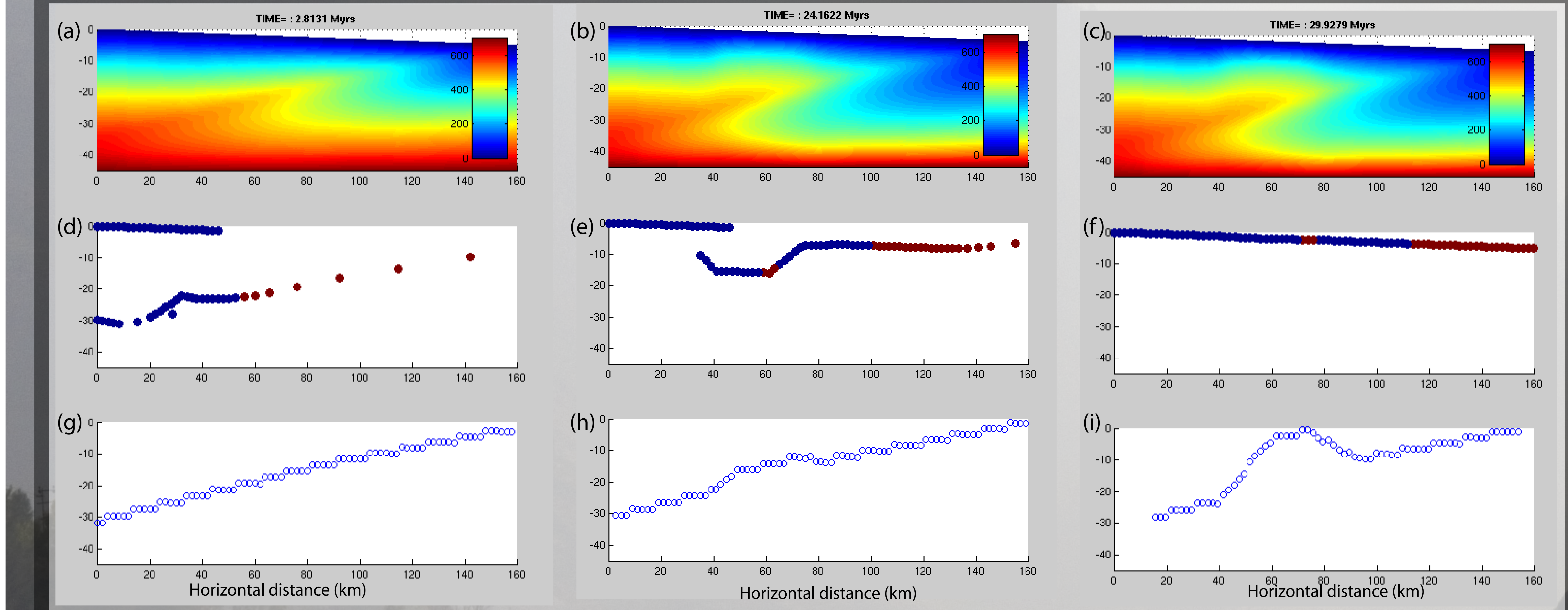

Figure 2: Evolution of thermal model (a)-(c) Thermal structure, (d)-(f) particles paths for rocks that end up at the surface at the end of the run, (g)-(i) evolution of MHT during model run.

References
Harrison, T.M., et al 1997, A late Miocene-Pliocene origin for Central Himalayan inverted metamorphism, Earth and Planetary Science Letters, 146, p. E1-E8.
Bollinger, L., et al 2004. Thermal structure and exhumation history of the lesser Himalaya., Tectonics
Sambridge 1999, Geophysical Inversion with a Neighbourhood Algorithm -I. Searching a parameter space Geophys. J. Int., 138, 479-494

Computations were performed on the Pangu facilties at the Geological and Planetary Sciences, California Institute of Technology.

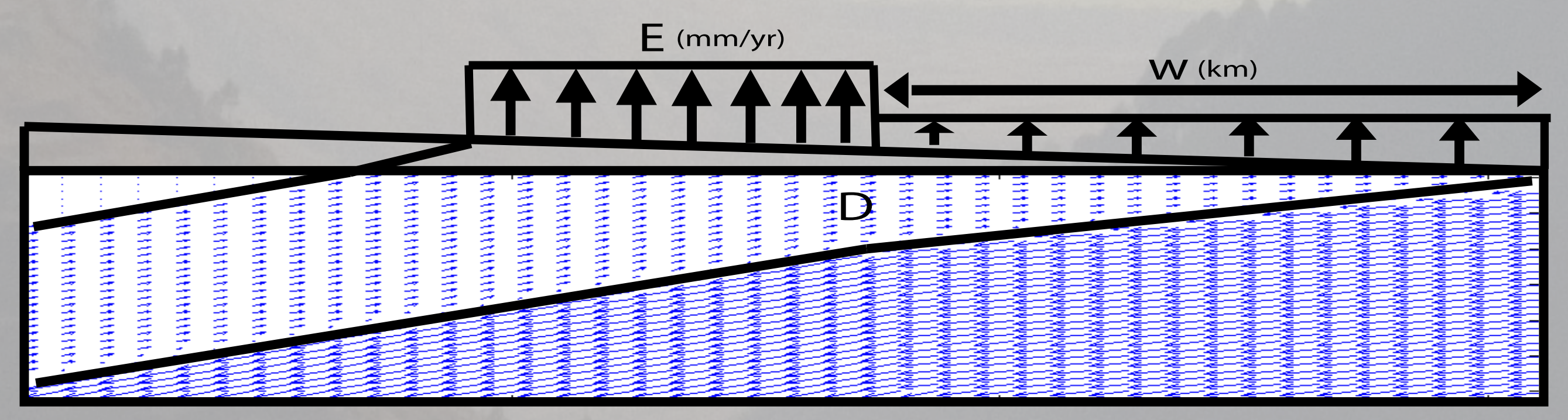

Figure 5: Kinematics used in thermal model. There is a window of accretion, the upper plate overthrust the lower plate at (1-ra)*v, with v being the total shortening rate.

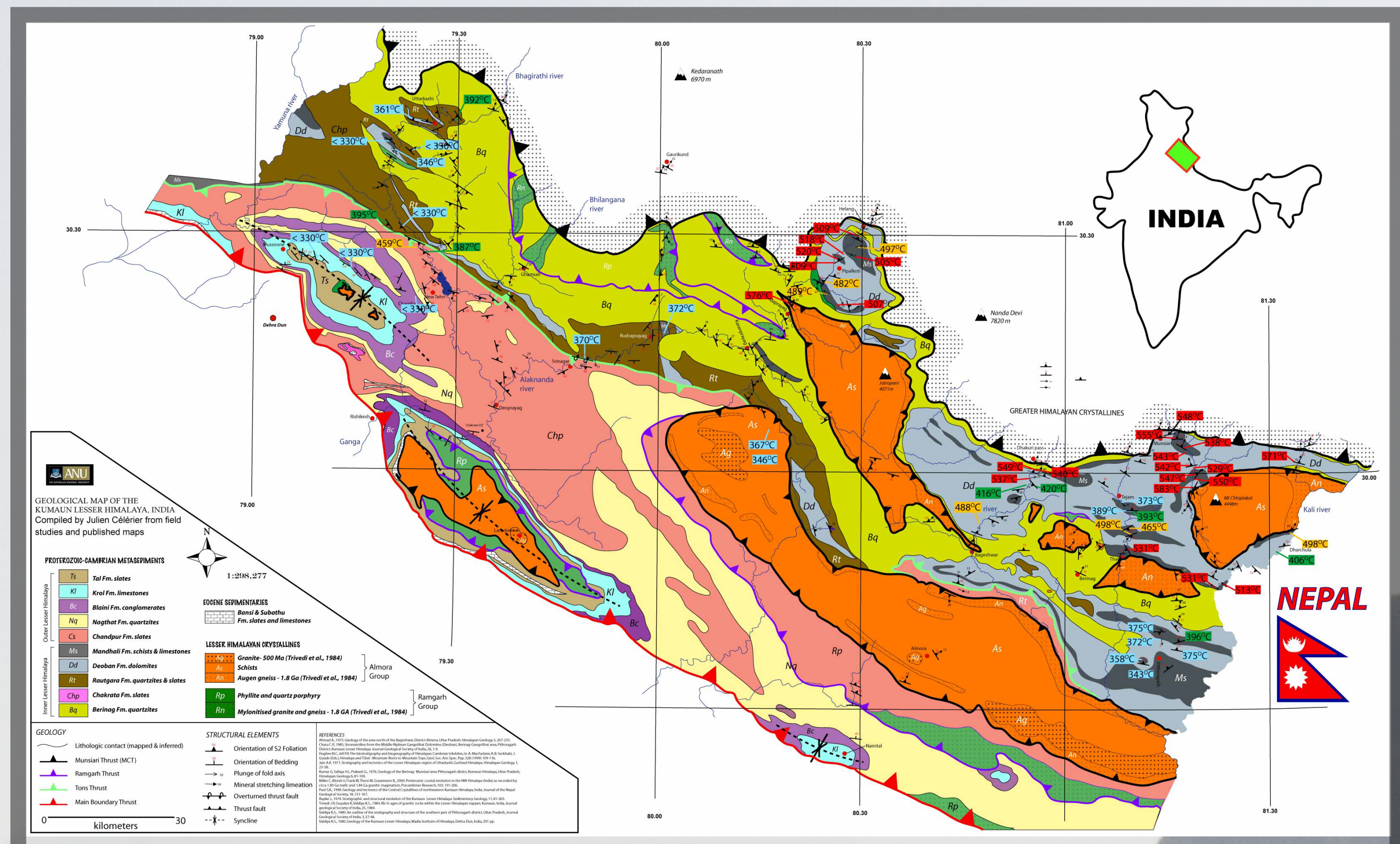

Figure 1: Geological map (courtesy of Julien Celerier)

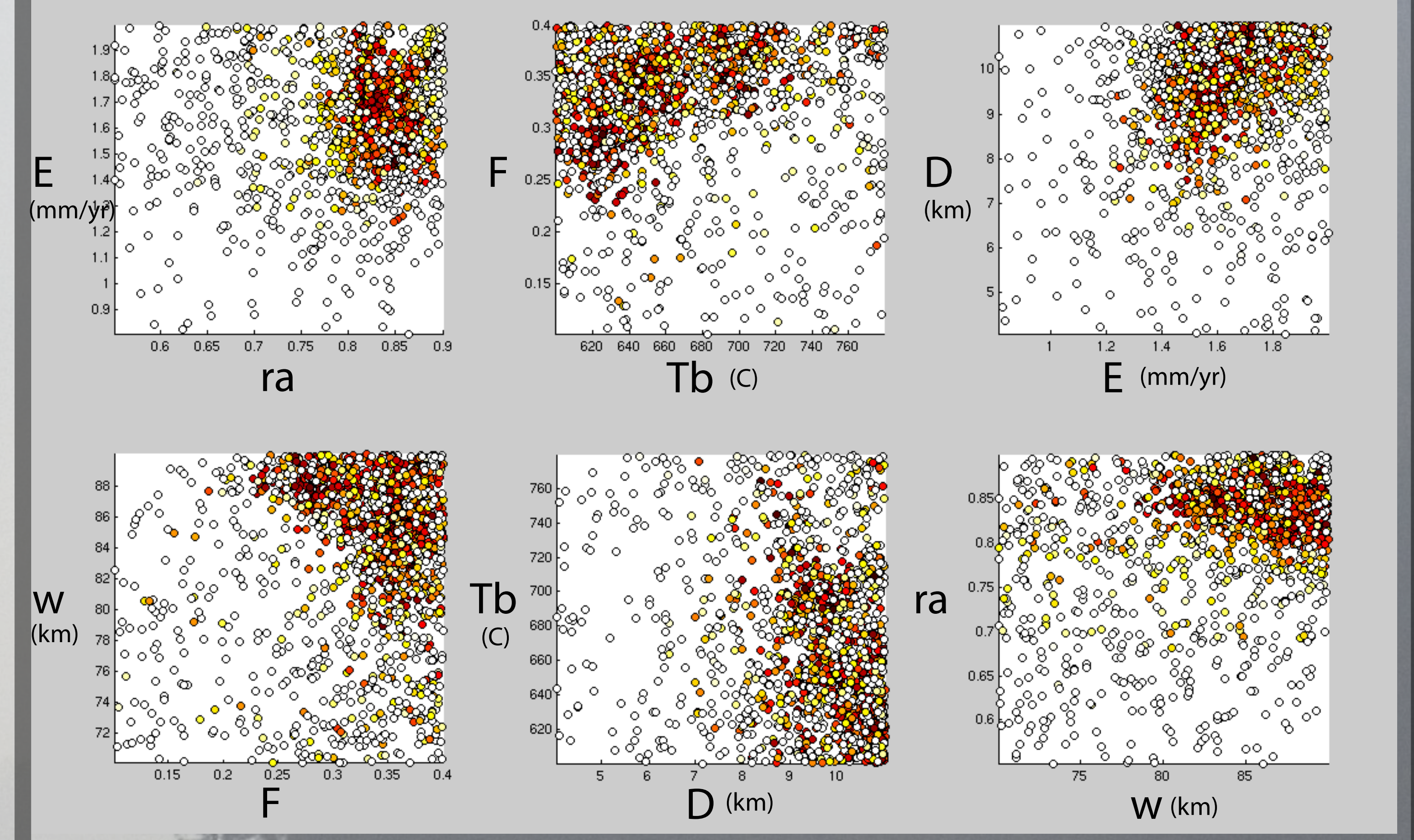

Figure 3: Inversion of thermal model. Each dot represents a forward model in the parameter space (white dots=low fit, red dots=goof fit)

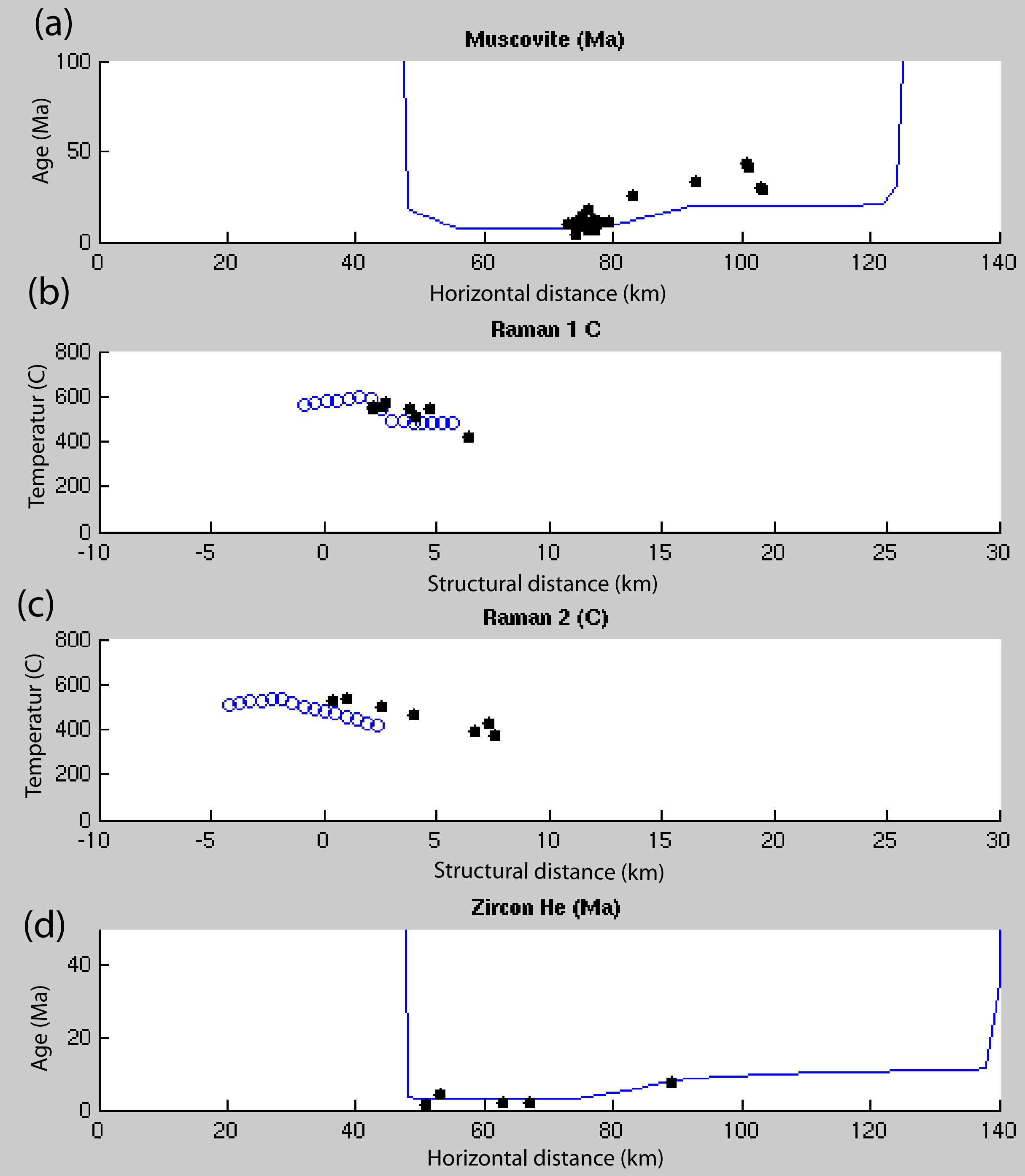

Figure 4: Fit to the data for a forward which minimizes the misfit. Black color scheme depicts data and blue model output.
(a) Ar39/Ar40 in muscovite vs. horizontal distance
(b) Raman peak temperature vs. structural distance near the MCT
(c) Raman peak temperature vs. structural distance 30 km south of MCT
(d) (U-Th)/He in zircon ages vs. structural distance