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The first direct dating of Main Central Thrust phyllonite demonstrates exhumation of the Greater Himalayan Crystalline had already taken place

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Here we report the results of step-heating experiments that allow the first direct dating of the timing of movement on the Himalayan Main Central Thrust (MCT). Timing of MCT operation has, until now, been inferred based on specific tectonic models, or with data not directly attributable to MCT movement, *e.g.*, the debatable assertion that leucogranite formation is invariably related to crustal shortening, and therefore that the MCT must already have been in operation. However the tectonic evolution may have been more complex, *e.g.*, at times involving horizontal extension. In any case, many different thrust systems operated during India-Asia convergence, and the MCT is only one of them. It is time to move away from models and to bring geology back into the equation.

Here we apply $^{40}Ar/^{39}Ar$ geochronology to directly date highly strained, phyllonitized, muscovite in the MCT above the Kullu-Rampur tectonic window (NW Indian Himalaya), showing that the timing of the shear movement lasted from 15–9 Ma. We show that these ages have been preserved because the white mica was sufficiently retentive of argon to be able to inhibit its diffusional loss at the temperatures and pressures in question. Arrhenius data from ultra-high-vacuum diffusion experiments show that deformation occurred below the closure temperature of this muscovite, for moderate cooling rates. Furthermore, we demonstrate that microscopic shear bands associated with MCT operation overprinted an earlier decussate mica growth. This decussate growth had taken place prior to $\sim$ 18 Ma. The decussate microstructure, together with foam textures in the host deformed quartzite, demonstrate that low deviatoric stress conditions applied during a prior period of static annealing under middle- to upper-greenschist facies conditions.

In this region, therefore, the Greater Himalayan Crystalline had therefore already been significantly exhumed prior to the onset of MCT operation. The foam textures in quartzite and the decussate intergrowths of mica match in age and character the effects of the Oligo-Miocene metamorphic event that had widespread effects across this region, coeval with the operation of extensional ductile shear zones and faults of the South Tibetan Detachment (STD) system. This means that regional exhumation of the crystalline series most-likely occurred as the result of extreme extension during STD time. The MCT at this location is a relatively late structure that overprinted STD fabrics and microstructures at least five million years after the main exhumation of the crystalline series.

It is widely agreed that the MCT had a pivotal role in the evolution and exhumation of the Greater Himalaya crystalline sequences. This aspect is central to models involving fold-nappes, channel flow, and wedge extrusion. All of these models imply that the crystalline core of the Himalaya was exhumed as the result of it being thrust southward by the MCT. However, there is no evidence that this is the case, and these data allow rebuttal of such models, at least in terms of the structures currently defined as representing the MCT in NW India.