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Orogenic listening posts along the margins of western Tethys reveal a major tectonic event involving extreme extension at the start of the Eocene–Miocene transition

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Orogenic listening posts have been established along the northern margins of western Tethys: i) in the west and central Alps; ii) in the Cyclades, Aegean Sea, Greece; and iii) along a traverse in the NW Himalaya. We report on modelling and simulation of data from the conjoint inversion of argon geochronology and ultra-high-vacuum (UHV) diffusion experiments, on rocks from these locations. In the Alps, samples come from either side of the Lepontine dome, a metamorphic core complex that resulted from orogen-parallel extension, with a major pulse of stretching coinciding with the onset of the Eocene–Oligocene transition. In the Cyclades, the samples come from Ios, a metamorphic core complex that began its existence at about the same time, related to extreme extension caused by southward rollback of the Hellenic slab, after an immediately preceding accretion event that incorporated Gondwanan slices into the terrane-stack. In the NW Himalaya, samples come from yet another Tethyan metamorphic core complex, the giant schist and gneiss dome that includes the Tso Moriri, in Ladakh, India.

Inversion of data from these locations reveals unprecedented detail in the inferred temperature–time curve, allowing recognition that a rapid cooling event took place in the lower plate of the detachment system at each of these locations, almost at the same time. We discuss the tectonic implications of a synchronised tectonic mode switch at the start of the Eocene–Oligocene transition. In each location there was a preceding period of compressional orogenesis, involving accretion of multiple tectonic slices to the terrane stack after an accretion event, followed by a period during which extreme extension of the continental lithosphere appears to have taken place. This supports our 2001 hypothesis that tectonic mode switches during collisional orogenesis are globally synchronized, in consequence of torque balance being continuously maintained in the planetary assemblages of moving lithospheric plates. Accretion events perturb that torque balance, with tectonic mode switches the result of mechanical adjustment caused by the creation of new subduction systems, with the initiation of rollback offering a potential explanation for the rapid exhumation of core complexes in the over-riding lithosphere.