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Accretion-controlled forearc deformation pulses recorded by high-pressure paleo-accretionary wedges: the example of the Hellenic subduction zone

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Subduction margins are the loci of a wide range of deformation processes occurring at different timescales along the plate interface and in the overriding forearc crust. Whereas long-term deformation is usually considered as stable over Myr-long periods, this vision is challenged by an increasing number of observations suggesting a long-term pulsing evolution of active margins. To appraise this emerging view of a highly dynamic subduction system and identify the driving mechanisms, detailed studies on high pressure-low temperature (HP-LT) exhumed accretionary complexes are crucial as they open a window on the deformation history affecting the whole forearc region.

In this study, we combine structural and petrological observations, Raman spectroscopy on carbonaceous material, Rb/Sr multi-mineral geochronology and thermo-mechanical numerical models to unravel with an unprecedented resolution the tectono-metamorphic evolution of the Late-Cenozoic HP-LT nappe stack cropping out in western Crete (Hellenic subduction zone). A consistent decrease of peak temperatures and deformation ages toward the base of the nappe pile allows us to identify a minimum of three basal accretion episodes between ca. 24 Ma and ca. 15 Ma. On the basis of structural evidences and pressure-temperature-time-strain predictions from numerical modeling, we argue that each of these mass-flux events triggered a pulse in the strain rate, sometimes associated with a switch of the stress regime (i.e., compressional/extensional). Such accretion-controlled transient deformation episodes last at most ca. 1-2 Myr and may explain the poly-phased structural records of exhumed rocks without involving changes in far-field stress conditions. This long-term background tectonic signal controlled by deep accretionary processes plays a part in active deformations monitored at subduction margins, though it may remain blind to most of geodetic methods because of superimposed shorter-timescale transients, such as seismic-cycle-related events.