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Insights into a fossil plate interface of an erosional subduction zone: a tectono-metamorphic study of the Tianshan metamorphic belt.

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Subduction zone seismicity and volcanism are triggered by processes occurring at the slab-wedge interface as a consequence of metamorphic reactions, mass-transfer and deformation. Although the shallow parts of subduction zones (<30-40 km) can be partly accessed by geophysical methods, the resolution of these techniques is insufficient to characterize and image the plate interface at greater depths (>60km). In order to better understand the plate interface dynamics at these greater depths, one has to rely on the rock record from fossil subduction zones.
The Chinese Tianshan metamorphic belt (TMB) represents an ideal candidate for such studies, because structures are well exposed with exceptionally fresh high-pressure rocks. Since previous studies from this area focused on fluid-related processes and its metamorphic evolution was assessed on single outcrops, the geodynamic setting of this metamorphic belt is unfortunately heavily debated. Here, we present a new geodynamic concept for the TMB based on detailed structural and petrological investigations on a more regional scale.
A $\sim$11km x 13km area was extensively covered, together with E-W and N-S transects, in order to produce a detailed map of the TMB. Overall, the belt is composed of two greenschist-facies units that constitute the northern and southern border of a large high-pressure (HP) to ultra high-pressure (UHP) unit in the center. This HP-UHP unit is mainly composed of metasediments and volcanoclastic rocks, with blueschist, eclogite and carbonate lenses. Only the southern part of the HP-UHP unit is composed of the uppermost part of an oceanic crust (e.g., pillow basalts and deep-sea carbonates). From south to north, the relative abundance and size of blueschist massive boudins and layers (as well as eclogite boudins) decreases and the sequence is increasingly interlayered with metasedimentary and carbonate-rich horizons. This indicates that the subducted material was dominated by trench filling made of sediments and volcanoclastic rocks, with only subordinate pieces of oceanic crust/lithosphere.
The whole sequence is cut by km-scale major shear planes orientated WNW-ESE showing consistent top-to-the north shear senses. Lineations marked by glaucophane indicate that most of the deformation occurred during exhumation-related blueschist-facies conditions. Peak pressure and temperatures (P-T) were estimated by Raman spectroscopy, using the degree of organisation of carbonaceous material in metapelites for T and Raman peak shifts of quartz inclusions in garnets for P. In the whole HP-UHP region, consistent and homogeneous peak P-T conditions of 530$\pm$30°C and 2.3$\pm$3 GPa point to depths around 70 km and HP to UHP conditions, which is further supported by the local presence of coesite.
The continuity of the lithological sequence and the lack of significant P/T offsets across the major shear planes indicate that, during exhumation, the HP-UHP unit primarily behaved as a single stack of essentially metasedimentary slices, and was only poorly dismembered on its way to the surface. Our study thus advocates for deep accretion/underplating and stacking of these tectonic slices (dominated by trench infill material) at depths of $\sim$70 km, which has so far rarely been documented.