

Pairing extreme metamorphism – A Tale of East Pangea supercontinent assembly

During the Paleozoic Era, pieces of continents were successively detached and transferred from Gondwana to Laurasia to form the Pangea supercontinent. During the supercontinent cycle, such transfers are associated to the break-up and reassembly of supercontinents that involve the opening and closure of short-lived oceans in the interior margins of the main continental landmass. Meanwhile, supercontinents also record accretion of continents related to the subduction of a relatively large and long-lived oceans along their exterior margins. Ultrahigh-pressure (UHP) metamorphic rocks form during mountain building (or orogeny) dominated by subduction-to-collision events related to the closure of interior oceans during the assembly of supercontinents. In contrast, ultrahigh-temperature (UHT) metamorphic rocks form during orogeny dominated by rifting and breaking-up of supercontinents. The construction of East Pangea coincided with the late stages of formation of the Central Asian Orogenic Belt corresponding to the amalgamation of three large tectonic collages: the Tarim-North China collage (TNCC) in the south, Mongolian collage (MC) in the north and Kazakhstan collage (KC) in the west. At ca. 320 Ma, the collision between Tarim and the KC in the interior of East Pangea led to the formation of UHP metamorphic rocks in the South Tianshan orogen. At the same time, the Altai orogeny of the MC recorded episodes of compression and extension related to the “advancing” and “rolling-back” of oceanic subduction zones analogue to those occurring in the exterior of Pangea. In the Altai orogen, this led to the formation of UHT metamorphic rocks during its collision with the Junggar plate of the KC. Altogether, the Tianshan and Altai orogens represent a unique example of pairing of extreme UHP and UHT metamorphism via interior and exterior orogeny, respectively, during the assembly of Pangea. Although this enigmatic process has no equivalent in the West Pangea, the corresponding sequence of tectonic deformation and metamorphic events recorded in rocks of the Tianshan and Altai orogens remain unresolved. As a consequence, whether the late Paleozoic amalgamation of the TNCC with both KC and MC during the assembly of East Pangea was driven by far field compression related to interior collision or by the roll-back a large oceanic subduction zone remains hotly debated. In order to fill these research gaps, this joint project (relying on the complementary competencies of the IGSPAS and the CGS-CLR) proposes to adopt a multidisciplinary and multi-scale approach combining the following methods: i) characterization of metamorphism using petrographic, structural and metamorphic rock studies, ii) dating of metamorphism using garnet Lu–Hf and Sm–Nd and zircon and monazite U–Pb geochronology and iii) characterization of rock deformation using quantitative microstructural analysis. Research tasks will include the reconstruction of the complete pressure-temperature-time-deformation (P – T – t – D) evolution of metamorphic rocks. The acquired data will allow the systematic study of these complete evolutions for both Tianshan and Altai orogens from Carboniferous to Triassic times. The data will be correlated with the deformation and age data of the Junggar domain connecting the Tianshan in the south to the Altai in the north and tested using new paleogeographically constrained orogenic-scale tectonic models for the region. The findings of this project will help us to understand 1) how interior and exterior orogenic systems interact with each other during the supercontinent cycle, 2) the mechanisms responsible for pairing UHP-UHT metamorphosis during orogeny and 3) the tectonic forces that controlled the final stages of the assembly of the Pangea supercontinent.