Geophysical Research Abstracts
Vol. 20, EGU2018-13593-1, 2018
EGU General Assembly 2018

Forearc basin tectonic evolution inferred from detrital zircon double dating: Insights from the Red Bed Series strata in the Zagros fold-thrust belt, Kurdistan Region of Iraq

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Forearc basin deposits record pivotal information regarding the geodynamic history and the paleogeographic setting of the convergent margins. Well-preserved ancient stratigraphic successions are rare due to erosion related to the collisional tectonics, challenging a superb understanding of the tectonic processes prior to collision. In the Kurdistan Region of Iraq, along the northwestern segment of the Main Zagros Fault footwall, discrete hinterland basin deposits of the Red Bed Series (RBS) are preserved. Debate persists whether the RBS strata have deposited in a foreland basin or in an intermontane basin that formed due to deformation of the obducted Neo-Tethys ophiolite rocks and the subduction-related prism. To decipher the RBS basin tectonics, we combined ages derived from the detrital zircon (U-Th)/(He-Pb) double dating method with information obtained through conventional U-Pb age provenance analyses. This research tests three competitive models for the tectonic setting of the RBS strata: (1) deposition in a foreland basin with zircon grain crystallization and exhumation ages similar to the ophiolite source rocks; (2) in an intermontane basin with zircon grain crystallization age similar to the ophiolite rocks, but dissimilar exhumation age relevant to timing of basin formation; and (3) in a forearc basin with identical zircon grain crystallization and exhumation ages, denoting synmagmatic deposition and arc provenance. Detrital zircon (U-Th)/(He-Pb) results exhibit identical ages of ∼60 Ma and ∼40 Ma, suggestive of a magmatic arc origin related to the adjacent Sanandaj-Sirjan Zone and Naopurdan-Walsh oceanic arc-back arc system. Samples from the Paleogene proto-Zagros foreland basin show a unimodal U-Pb age distribution at ∼95-100 Ma, which points an origin from the ophiolitic terranes. These ages are thus drastically different from the RBS provenance data. The U-Pb age spectra from the upper part of the RBS, which is separated from the lower part by an Oligocene unconformity show a dominant ∼40 age peak and lack of the ∼60 Ma age peak. Such an age signature is comparable to the provenance of the youngest formations in the Neogene-Zagros foreland basin, implying hinterland connectivity with the foreland basin during the Neogene, but not earlier. Shift in provenance, cessation of arc magmatism by the Oligocene, and the occurrence of the unconformity are interpreted to mark the onset of the collision between the arc-related terranes and the Arabian continental plate. Ultimately, the detrital zircon (U-Th)/(He-Pb) data advocate the deposition of the RBS in a forearc basin setting adjacent to the arc magmatic terranes of the Sanandaj-Sirjan Zone during the Paleocene-Eocene. After arc-continent collision, the RBS deposits evolved into the present-day hinterland setting, and the RBS strata became recycled into the Neogene-Zagros foreland basin. The abovementioned evidences highlight the role of the arc-continent collision and the related forearc basin deformation in controlling provenance, degree of clastic sediment maturation, and the source-to-sink connectivity in the Neogene-Zagros foreland basin.