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U-Pb age and Hf isotope data of detrital zircons of exotic Devonian sandstones from the southeastern Rheinisches Schiefergebirge near Giessen, Germany

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In the Rhenohercynian zone, southeastern Rheinisches Schiefergebirge, of Germany early and late Devonian sedimentary successions of suspect provenance occur in the allochthonous assemblage of the Lindener Mark south of Giessen and the Giessen nappe. Both tectonic units were emplaced over the autothonous Rhenohercynian units as northward moving nappes during the Variscan orogeny. A combination of faunal and sedimentological data suggested that the allochthonous sedimentary successions do not belong to the Rhenohercynian zone as part of the southern margin of the Old Red Continent and most likely derive originally from northern Gondwana.
In order to test the interpretation of a NW African origin of the Hercynian units we applied U-Pb detrital zircon age determination and Hf isotope analysis by laser-ablation-sector field-inductively coupled plasma mass spectrometry (LA-SF-ICP-MS). We studied the Dalmanitensandstein in the Lindener Mark south of Giessen, the Giessener Grauwacke, Kalkige Grauwacke and the Erbslochgrauwacke near Marburg and Densberg. We analyzed around 150 detrital zircons of each sample and considered only ages which are less than 10% discordant. Viewed synoptically the age distributions of all 5 samples are very similar. The U-Pb ages range between 3300 Ma and 372 Ma. The age distributions show two major peaks in each of the samples. The older peak is around 2000 Ma with ∼27% of ages, the younger one is around 600 Ma with ∼71% of ages. Ages between 1650 and 1200 Ma are very scarce (∼2%). These essentially bimodal zircon age spectra are similar to typical NW African zircon age spectra with the main abundances connected to the Eburnean and Cadomian orogenies at c. 2000 Ma and c. 600 Ma, respectively. Contrastingly, siliciclastic units derived from the Old Red Continent to the north include abundant zircon ages between 2000 and 1000 Ma.
The Hf isotope patterns of the samples of all studied formations are also very similar. The Hf isotopic compositions of selected dated zircons (n=208) at the time of their crystallization (epsHf(T); T=3.3-0.38 Ga) vary between –33 and +12. 42% of all zircons have positive epsHf(T) and can be considered to contain juvenile components. Truly juvenile compositions, i.e. within 5 epsilon [U+F020] units of the depleted mantle (MORB) evolution trend, are represented by 15% of data. The majority of the juvenile grains have Hf depleted mantle model ages (Hf TDM) between 1.7 and 1.2 Ga, with a peak between 1.5 and 1.4 Ga. The total range of Hf TDM is between 3.2 and 0.64 Ga. The Hf isotope data form two vertical arrays in time vs epsHf(T) space, corresponding to the two main age peaks at c. 2.0 and 0.6 Ga. epsHf(T) values of the former range between +7 and -33, those of the latter are between +12 and -33. This suggests that both crust formation events involved mixing of juvenile magmas with variable amounts of old crustal components. These data are in accordance with similar data from Saxothuringian units also of NW African provenance.
In combination our data confirm that the allochthonous stratigraphic units of the Lindener Mark and the Giessen nappe in the Rhenohercynian zone originally derive from a position in NW Africa.