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Tracing source terranes using U-Pb-Hf isotopic analysis of detrital zircons: provenance of the Orhanlar Unit of the Palaeotethyan Karakaya subduction-accretion complex, NW Turkey

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Sandstones of the Late Palaeozoic-Early Mesozoic Karakaya Complex are interpreted to have accumulated along an active continental margin related to northward subduction of Palaeotethys. The age of deposition and provenance of the sandstones are currently being determined using radiometric dating of detrital zircons, coupled with dating of potential source terranes. Our previous work shows that the U-Pb-Hf isotopic characteristics of the sandstones of all but one of the main tectonostratigraphic units of the Karakaya Complex are compatible with a provenance that was dominated by Triassic and Permo-Carboniferous magmatic arc-type rocks, together with a minor contribution from Lower to Mid-Devonian igneous rocks (Ustaömer et al. 2015). However, one of the tectono-stratigraphic units, the Orhanlar Unit, which occurs in a structurally high position, differs in sedimentary facies and composition from the other units of the Karakaya Complex. Here, we report new isotopic age data for the sandstones of the Orhanlar Unit and also from an extensive, associated tectonic slice of continental metamorphic rocks (part of the regional Sakarya Terrane). Our main aim is to assess the provenance of the Orhanlar Unit sandstones in relation to the tectonic development of the Karakaya Complex as a whole. The Orhanlar Unit is composed of shales, sandstone turbidites and debris-flow deposits, which include blocks of Devonian radiolarian chert and Carboniferous and Permian neritic limestones. The sandstones are dominated by rock fragments, principally volcanic and plutonic rocks of basic-to-intermediate composition, metamorphic rocks and chert, together with common quartz, feldspar and mica. This modal composition contrasts significantly with the dominantly arkosic composition of the other Karakaya Complex sandstones. The detrital zircons were dated by the U-Pb method, coupled with determination of Lu-Hf isotopic compositions using a laser ablation microprobe attached to a multicollector-inductively coupled plasma-mass spectrometer (LA-MC-ICP-MS) at Goethe University, Frankfurt. A total of 399 U-Pb spot analyses were carried out on zircons from the sandstones of the Orhanlar Unit. 84% of the data yielded Precambrian ages, which is in marked contrast with the typical arkosic sandstones of the Karakaya Complex in which Precambrian zircons form only 10% of the population. Three zircon grains of Ladinian age suggest a maximum depositional age for the Orhanlar Unit. The most prominent zircon population is of Ediacaran-Cryogenian age (31%). The second largest population is Tonian-Stenian (22%), the third largest Cryogenian-Tonian (9%) and the fourth Devonian-Carboniferous (7%). There are also minor zircon populations of Palaeoproterozoic and Neo-Archean ages. The Precambrian zircon populations in the Orhanlar Unit sandstones are identical to those in the schists of the Sakarya continental crust (P.A. Ustaömer et al. 2012; this study). Their Hf isotope compositions also overlap, suggesting that the Sakarya continental crust could be a source for the sandstones of the Orhanlar Unit. On the other hand, the [U+F065]Hf(t) values of most of the Devonian and Carboniferous detrital zircons differ from those of the Devonian and Carboniferous granites that intrude the Sakarya continental crust. The Karakaya Complex as a whole appears to have been derived from two different source terranes, of which the Orhanlar Unit sandstones represent a minor, but significant component. Possible explanations are that two different source terranes already existed in the same region but that these were not exposed to erosion at the same time or, if exposed simultaneously, experienced different depositional pathways (without mixing); alternatively, the Orhanar Unit represents part of a different tectono-stratigraphic terrane from the other Karakaya Complex units, with which it was tectonically amalgamated prior to Early Jurassic deposition of a common sedimentary cover.

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