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Geochemistry, provenance and tectonic setting of Late Cambrian-Early Ordovician metaclastic rocks from the Çaltepe (Seydişehir) and Fele (Şarkikaraağaç) districts, Southern Turkey

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The major, trace and rare earth element (REE) content of metapelite (MPL), metapsammite (MPS) and metamarl (MM) samples from the Cambro-Ordovician Seydişehir Formation were analyzed to explain and compare their provenance and tectonic setting. The chemical index of alteration (CIA) and chemical index of weathering (CIW) ratios vary between 50.10 and 81.22 and between 53.69 and 97.80, respectively. However, most samples have ratios greater than 60, indicating a moderate to high degree of alteration in the source area. On average, the analyzed samples show slight enrichments in SiO_2, but their K_2O, Rb, Ba, Th and U contents resemble those of the Upper Continental Crust (UCC) and post-Archean Australian shale (PAAS). The samples are strongly depleted in MnO, CaO, Na2O, and Pb, and slightly in TiO_2, Al_2O_3, Fe_2O_3, MgO and P_2O_5 relative to the PAAS content. The MPS, MPL, and MM sample suites show variable SiO_2 concentrations, with average values of 70.73, 55.54, and 20.63 %, moderate SiO_2/Al_2O_3 contents (mean 5.6- 3.1- 5.3), moderate-to-high Fe_2O_3+MgO contents (mean 5.0- 9.5- 3.6 wt %), and high K_2O/Na_2O ratios (mean 2.8 - 3.5 - 2.6). In general, the concentrations of both the high-field-strength elements (HFSE) and the transition trace elements (TTE) are low in the Seydişehir sediment groups compared with those of the UCC. These trends are typical for clastic rocks derived from recycled upper crustal material. However, the total REE concentrations of the MPL and MPS are higher than those of the MM, PAAS, and UCC. In contrast, chondrite-normalized REE patterns of the MPL, MPS, and MM are very similar and are characterized by subparallel LREE-enriched and relatively flat HREE diagrams with [$(La/Yb)_N$ = 4.75–13.03] ratios and negative Eu anomalies. The higher REE contents of the MPL and MPS sample suites indicate that recycling processes in the Çaltepe and Fele source areas were probably more intense than in PAAS and UCC. In addition, the wide range of TiO_2/Zr ratios may also be related to extensive sorting. The chondrite-normalized REE patterns, plots of sediments in ternary diagrams for La, Th, Sc and some elemental ratios (e.g., La/Sc, Th/Sc, Cr/Th, Eu/Eu*, La/Lu, Co/Th, La/Sc and Sc/Th) indicate that the Seydişehir clastic sediments were derived dominantly from felsic to intermediate magmatic rocks, not from mafic source rocks. The Eu/Eu* ratios (0.6–0.8) indicate the weathering of a mostly granodiorite source rather than a granite source, consistent with a source from the old upper continental crust. The La-Sc-Th and Th-Sc-Zr/10 ternary diagrams of the Seydişehir Fm are typical of the tectonic settings of a continental island arc/active continental margin. Its geologic position and geochemistry also indicate that the Seydişehir Fm was deposited in a back-arc basin known as the Proto Tethyan Ocean or Early Paleo-Tethyan Ocean during the Late Cambrian-Early Ordovician period, and it was most likely sourced from the Precambrian felsic magmatic and low-grade metaclastic rocks of the Menderes Massive and Sandıklı (Afyon) basement complex located in the western to northwestern parts of the study areas.