Distribution of environmentally significant trace elements of the Tertiary bituminous shale deposits in NW Anatolia, Turkey

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There are 1.6 billion tones of bituminous shale reserve in 6 different fields in NW Anatolia, Turkey. In this study, environmental element concentrations (As, Cd, Cr, Cu, Hg, Mn, Pb and Zn) and enrichment factors of bituminous shales and element-organic matter relations were investigated and characteristics of fields were compared.

The maximum and minimum concentrations of environmental elements are As: 3.16-55.58 µg/g, Cd: 0.06-0.22 µg/g, Cr: 8.69-114.14 µg/g, Cu: 18.69-38.67 µg/g, Mn: 401.13-1451.50 µg/g, Pb: 4.62-16.32 µg/g, Zn: 23.93-50.02 µg/g and Hg: 17.33-77.07 ng/g. With enrichment factors (EF) less than one, Cr, Hg and Pb concentrations of the Bahçecik field and Hg contents of the Gölpazarı field are depleted with respect to average shale values while other elements are enriched. In general, Hg shows the least enrichment and the highest enrichment was calculated for As. The highest and lowest enrichments for As were found in the Hatıldağ (EF=35.28) and Bahçecik (EF=1.01) fields, respectively. In general, all elements are highly abundant in the Beypazarı and Seyitömer fields and they have low concentrations in the Himmetoğlu, Bahçecik and Gölpazarı (except for As) fields.

It was determined that the average Cd, Cu, Pb, Zn and Mn concentrations in all the fields are below the critical levels proposed for the soil (however, manganese concentration of the Bahçecik field is very close to the critical value). As concentrations in the Hatıldağ and Gölpazarı fields, Cr concentrations in the Hatıldağ, Gölpazarı and Seyitömer fields and Hg concentrations in the Himmetoğlu, Hatıldağ and Seyitömer fields are higher than critical soil levels. A positive correlation between total organic carbon (TOC)-As and TOC-Pb at a significance of $p \leq 0.01$ and 0.05 was found in none of the fields. A positive correlation at significance of $p \leq 0.05$ was observed for TOC content with Cd in four of the fields, with Cu in two fields and with Cr, Mn and Zn in only one field.

^{40}Ar-^{39}Ar dating of mineral separates of shergottite Dhofar 019

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^{40}Ar-^{39}Ar thermochronology of SNC-meteorites yields insights into the thermal history, crystallization and cratering events of the martian lithosphere. We applied high-resolution ^{40}Ar-^{39}Ar dating to the olivine-phyric shergottite Dhofar 019 (whole rock, mineral separates). The intermediate/high temperature extractions of Dhofar 019 maskelynite, pyroxene and olivine separates suggest trapped argon with $^{40}Ar/^{36}Ar$~300-400. Corrected age spectra show plateaus with similar ages of 642±72 Ma for maskelynite (~91% ^{39}Ar release) and 603±96 Ma for pyroxene (~60% ^{39}Ar release), the latter separate being dominated by maskelynite impurities. These ages are compatible with Sm-Nd and Rb-Sr ages [1]. In the olivine separate, the melt inclusions within olivine megacrysts [2] control the age spectrum. After correction for trapped argon, the extractions releasing 26-81% ^{39}Ar display an age of 1086±252 Ma. This age could date the entrapment of a magmatic liquid during crystallization. On the other hand, the higher age of the olivine separate compared to maskelynite could be caused by incomplete degassing during shock metamorphism. ^{38}Ar CRE ages determined from stepwise release age spectra of Dhofar 019 pyroxene and maskelynite are highly concordant with an average age of 15.7±1.1 Ma.

The young Rb-Sr/Sm-Nd and Ar-Ar ages of shergottites were usually regarded as crystallization ages [3]. Currently, there are strong debates about the interpretation of young Rb-Sr/Sm-Nd and Ar-Ar ages for shergottites, envisaging much older crystallization ages [e.g., 4, 5]. Although shergottites are severe shocked rocks, Rb-Sr, Sm-Nd and Ar-Ar chronometers cannot suffer a major reset by mere shock effects, e.g. conversion of feldspar to maskelynite causes only minor ^{40}Ar loss [5]. Complete reset by ^{40}Ar loss would require much stronger local shock wave effects (e.g., melt formation as observed for L chondrites [6]) or substantial accompanying heating effects (e.g., impact melt sheet covering, as could be the case for eucrites [7]).

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