Primitive high-K ankaramites and the evolution of the Eastern Srednogorie arc in SE Europe

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The Eastern Srednogorie arc in Bulgaria formed by the northwards subduction of the Tethyan Ocean beneath the European continental margin in the Late Cretaceous. In contrast to other continental arcs, the Eastern Srednogorie is characterized by unusually large volumes of mafic shoshonitic and ultra-K magmatism, represented by high-Mg cumulitic rocks, nepheline-normative ankaramites, absarokites and shoshonitic (high-alumina) basalts

We present the mineralogy, major, trace element and whole-rock Sr and Pb isotope data of these mafic rocks and entrained lower crustal clinopyroxenite xenoliths. The most primitive rocks are high-K and high CaO ($CaO/Al_2O_3>1$) ankaramitic basalts, which also have high Ni and Cr contents and the least radigenic Sr and Pb isotopes in Eastern Srednogorie. Melt inclusions hosted in high-Fo olivine of the cumulitic rocks have similar compositions, which implies that the chemical characteristics of the ankaramites are primary magma features and not the result of clinopyroxene accumulation. Thermobarometry of the ankaramites suggest crystallization conditions at ca. 7-9 kilobars, temperatures of ~1200-1250°C, oxidized conditions and high water contents.

The generation of the primitive high-K ankaramitic magmas is explained by melting of clinopyroxene-rich amphibole- and/or phlogopite containing lower crustal cumulates or a garnet-free metasomatized upper mantle source. The more evolved absarokites and trachybasalts formed by fractionation of an olivine-clinopyroxene dominated assemblage from the parental ankaramitic magma.

Regional geology, U-Pb ID-TIMS and LA-ICPMS zircon age dating of the magmatism in Eastern Srednogorie show that the mafic high-K volcanism formed at ca. 80 Ma in an intra-arc rift, which divided a slightly older calc-alkaline arc in two. Most probably, the intra-arc rifting was caused by a southward trench retreat and associated roll-back of the subducting oceanic slab.

Export fluxes from submarine venting to the ocean: A synthesis of results from the Rainbow hydrothermal field, 36°N MAR

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High-temperature hydrothermal activity occurs in all ocean basins and along ridge-crests of all spreading rates. While it has long been recognized that the fluxes associated with such venting are large, precise quantification of their impact on ocean biogeochemistry has proved elusive. Here we report the first comprehensive study of heat, fluid and chemical fluxes from a single submarine hydrothermal field to the oceans. To achieve this, we have exploited the integrating nature of the non-buoyant plume dispersing above the Rainbow hydrothermal field, a long-lived and tectonically-hosted high-temperature vent-site on the Mid-Atlantic Ridge. Our calculations yield heat and volume fluxes for high-temperature fluids exiting the seafloor of ~0.5GW and 450L.s^{-1}, respectively. Accompanying fluxes for 28 chemical species as they are exported to the deep ocean across a sill located ~4km down-current from the Rainbow vent-site include fluxes of ~1mol.s^{-1} for Mn and CH_4 and ~10mol.s^{-1} for Fe. Importantly, our study indicates that high-temperature venting dominates over any on-axis diffuse-flow at the Rainbow vent-site. While the values reported here should probably not be considered representative of fluxes from hydrothermal venting to the oceans along medium, fast and super-fast spreading ridges, our calculations indicate that vent-sites comparable to Rainbow, spaced every 100-120km along axis, could dominate high-temperature fluid flow along the ~30,000km of slow and ultra-slow spreading ridges that comprise ~50% of the global total, extending from the Arctic Ocean, along the entire Mid-Atlantic Ridge and into the SW Indian Ocean.