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Initial results for the composition of the igneous basement of the Bowers and Shirshov Ridges (Bering Sea, NW Pacific)

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The Bowers and Shirshov Ridges (hereafter BR and SR, respectively) are two prominent submarine structures of unknown age and provenance in the Bering Sea. So far only a few geochemical data exist on the composition of basement rocks from the SR (Silantyev et al., 1985) and none for the BR. Age and geochemical data are crucial to evaluate if the ridges represent remnant island arcs (Cooper et al. 1981, Scholl 2007), former pieces of Kamchatka rifted away through seafloor spreading (SR: Baranov et al. 1991) or parts of the Mesozoic Hawaiian hot-spot (Steinberger & Gaina, 2007).

Here we report the first geochemical data on the composition of the basement rocks from the BR and SR, recovered during KALMAR R/V SONNE cruise 201 (Legs 1b and 2) in 2009. Fresh to moderately altered volcanic rocks were dredged from the northern slope of the BR, from seamounts on the western extension of the BR and from the western slope of the central part of the SR. We studied the petrography of the samples and carried out geochemical analyses of major and trace elements by XRF and ICPMS at ACME Lab (Vancouver, Canada) and CAU (Kiel).

The rocks from the northwestern slope of the BR are clinopyroxene (cpx)-phyric basalts with minor amounts of olivine (ol) and plagioclase (plag) microphenocrysts, as well as hbl-plag-cpx-bearing basaltic andesites and trachyandesites. The rocks are strongly enriched in LREE (La_N/Yb_N = 3.2 – 8.5, N indicates normalization to primitive mantle), fluid-mobile elements (Ba, U, K) relative to NMORB and exhibit clear negative anomalies of HFSE (Nb, Ta and Ti) in primitive mantle-normalized incompatible element diagrams. The BR rocks also have a moderate adakitic signature, as indicated by elevated Sr_N/Y_N ratios (6.9 – 12.9). Hbl-cpx-plag trachybasalts from the SR have similar major and trace element compositions (La_N/Yb_N = 2.1 – 4.9) to the BR rocks. The other magmatic series from the SR comprises massive trachyandesites, trachytes and dacites with rare phenocrysts of plag and cpx. These rocks also have island-arc type incompatible element patterns and are distinct from other rock types from the BR and SR with less LREE enriched patterns (La_N/Yb_N ~ 1.8) and a strong negative Eu anomaly (Eu/Eu* = 0.74).

Rocks dredged from a seamount on the western extension of the BR have very distinctive petrographic and geochemical characteristics. These are ol-phyric pillow basalts with minor (less than 5%) amounts of plag and cpx. The freshest whole rocks and pillow-rim glasses have relatively smooth patterns of incompatible trace elements, akin to intraplate oceanic basalts and in some characteristic incompatible element ratios (e.g. Th_N/Ba_N = 0.6, Sr_N/Ce_N = 1.2, La_N/Yb_N = 3.3) are similar to Hawaiian hotspot tholeiites.

In summary, petrography and preliminary geochemical results indicate an island-arc origin for major parts of the BR and SR. The discovery of intraplate basalts suggests that fragments of the Emperor Seamount Chain could also be preserved in the Bering Sea (Steinberger & Gaina 2007) as seamounts and in the BR and SR basement. Our further studies will be focused on obtaining absolute age data for the studied rocks, which will allow combining the petrologic data with tectonic and geodynamic models for the NW Pacific.