

Evolution of a convergent plate margin from subduction to collision: A boron isotope study of the Kohistan Island Arc

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Subduction-zone magmas are characterised by isotopically heavy boron derived from the subducted slab, which evolves with the age, distance from the trench and thermal state of the subducting slab, and contrasts between arc and back-arc [1]. These insights are derived from young volcanic rocks from active subduction zones, but they only provide time snaps of the contemporary arcs. They do not allow to directly reconstruct the secular evolution of a convergent margin. This can only be achieved in an exhumed arc. We therefore chose the Kohistan Island Arc (KIA) for this purpose, which is the world's most complete section of arc mantle and crust.

The KIA depicts three consecutive tectonic environments: (i) a history of an open-ocean intra-oceanic arc from (154–90 Ma); (ii) arc splitting with back-arc magmatism (85–55 Ma), and (iii) subduction leading to arc-continent collision (55–30 Ma). In the KIA sequence these are represented by the Jijal or Southern Complex, the Chilas Complex and the Kohistan Batholith, respectively. The distinction of these tectonic intervals is also shown to be mirrored in signatures of radiogenic isotope ratios (Sr, Nd, Hf, Pb) [2].

To unravel the B isotopic composition of KIA and to decipher their co-evolution with the radiogenic isotope signatures, we analysed whole-rock boron isotopes by LA-ICPMS on pressed pellet nano-powders at FIERCE. The positive (up to +12 ‰) $d^{11}\text{B}$ values of the structurally lowermost mantle-section imply sub-arc slab-mantle interaction. The B isotopic composition (avg. +3.4 ‰) of the Chilas-Complex magmatic rocks formed during the 85 Ma back-arc rifting is indicative of the slab-derived heavy boron, and this shifts to lower- $d^{11}\text{B}$ continental signatures after the closure of the Tethys and subsequent Indian–Eurasian collision at around 55 Ma, with consistently negative $d^{11}\text{B}$ values (approximately -18.4 to 0 ‰). We find a correlation of $\delta^{11}\text{B}$ with whole-rock Nd and zircon Hf isotopic compositions reported previously [2]. Whole-rock $d^{11}\text{B}$ shows an age evolution throughout the KIA and reflects distinct tectonic settings.

[1] Marschall HR, Foster GL (2018) Boron Isotopes: Fifth Elem. Advan. Isot. Geochem. 351 p.

[2] Jagoutz et al. (2019) Geol. Soc. Spec. Publ., 483: 165–182.