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Editorial: Advances in the spatial and temporal evolution of oceanic arc-backarc systems

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Editorial on the Research Topic
Advances in the spatial and temporal evolution of oceanic arc-backarc systems

Oceanic arcs and their associated backarc basins are highly dynamic systems as their evolution is strongly linked with far-field plate tectonic stresses, the regional geodynamic setting, local crustal structure, and mantle dynamics. The individual evolutionary stages of arc and backarc systems are associated with significant changes in the physical and chemical conditions that control the compositions of melts during generation, transport, and storage, and eventually volcanic eruption. The magmas are generated under variable conditions that range from fluxed melting due to the devolatilization of the slab underneath the forearc and arc to dry adiabatic decompression melting of the mantle, especially underneath the backarc (Figure 1). The structure, composition, and geometry of the slab from the forearc to the backarc thus exerts an important control on metamorphic and metasomatic processes and melting in the overlying mantle wedge. This Research Topic covers the spatial evolution of arcs from the mantle (Bénard et al.; Bénard) through the crust (Kutyrev et al.) to the hydrothermal systems (Klose et al.) and from the forearc (Albers et al.) to the backarc (Anderson et al.; Dyriw et al.). The temporal and spatial reconstruction of the geological and structural evolution of the seafloor (Anderson et al.; Dyriw et al.) substantially improves our understanding of the evolution of convergent margins and microplate tectonics. All contributions to this Research Topic target localities in the western Pacific where the geodynamics and the evolution of convergent margins are spatially and temporarily complex.

The contributions by Bénard et al. and Bénard target the role of silicate melts from refractory spinel harzburgites in forming sulfide-bearing orthopyroxenites in the lithosphere. They show that the cooling of orthopyroxenites from their parental melts can concentrate chalcophile and siderophile elements in the lithosphere. Bénard et al. provide partition coefficients complemented by Bénard who presents and discusses the implications arising from the compositional range of vein sulfides.

Kutyrev et al. provide a noble metal perspective on the processes of mantle melting in the Kamchatka Arc. The authors use platinum group elements and gold contents from their

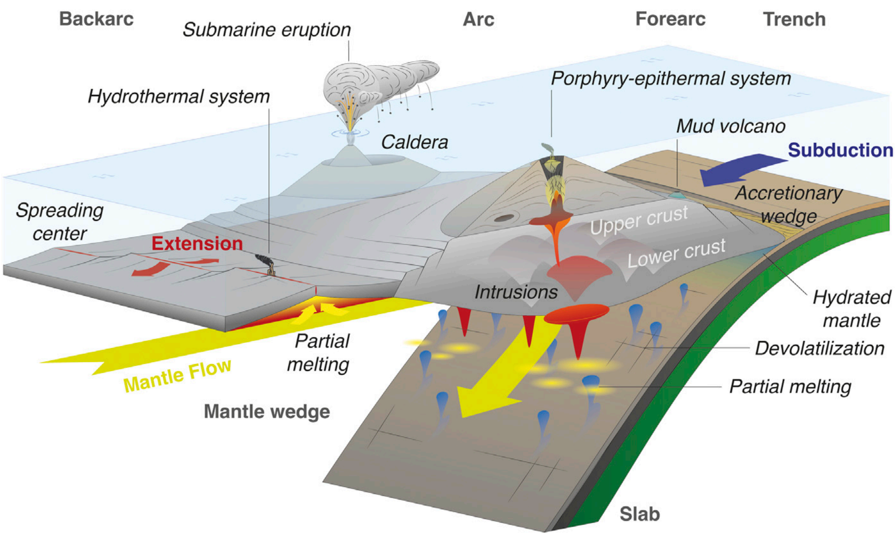

FIGURE 1
Idealized three-dimensional illustration of an intra-oceanic subduction zone and its associated arc-backarc system. Whereas partial melting underneath the arc front is mainly controlled by fluids fluxed from the subducting slab, the melting underneath spreading centers in backarc basins is dominated by adiabatic decompression in an extensional stress regime. Magmatic-hydrothermal ore systems are common in these settings and their location is controlled by regional geodynamics, magmatism, and local tectonics.

samples to develop a model in which the noble metal budget of arc magmas is variably controlled by the absence of sulfide melts. A lack of correlation between noble metals and gold contents suggests that the gold budget is being affected by recycling in the shallow magma plumbing system. The authors show that noble metal contents can be used to decipher the refertilization processes in the sub-arc mantle.

Klose et al. present fluid and pyrite compositions from two neighboring fluid vents at the Maka axial volcano in the Northeastern Lau Spreading Center. The compositional range in the fluids suggests a mixing of three distinct sources including a low chlorine vapor phase, a metal-rich black smoker-type fluid, and a significant contribution from seawater. The pronounced enrichment of the black smoker fluids results in a compositional overlap of the pyrite from both localities. Their geodynamic model includes subsurface conditions in which varying water-rock ratios, host rock-controlled redox conditions, and the quantity of seawater entrainment affect the hydrothermal fluid compositions and associated pyrites.

Albers et al. focus on the low-pressure/low-temperature mass transfer from the subducting slab in the forearc. Their findings imply that the geochemical and petrological forearc modification by dehydration significantly affects the composition of the subducting slab which has important implications for mass balance and mass transfer to the deeper mantle levels. A consistent increase in SiO_2, MgO, Na_2O, and K_2O suggests that the petrological phase transitions at the deeper, mantle level is significantly affected by mass redistribution from shallow slab levels.

Anderson et al. combine morphotectonic observations from new bathymetric data in the northeast Lau backarc basin to develop a model of the plate tectonic evolution. They show that the evolution of differently-oriented spreading centers depends on the reactivation of pre-existing structures which ultimately control the distribution of volcanism and hydrothermal venting in the region.

Dyriw et al. target the morphotectonic evolution of the eastern Manus backarc basin and link the structural evolution with the formation of massive seafloor sulfide deposits. The authors can show that the enigmatic formation of massive sulfide deposits is closely linked to the individual evolutionary phases of the basin from an extension of pre-existing arc crust to initial rifting and to the formation of a half-graben system with concurrent axial volcanism in which massive sulfide occurrences are bound to intersecting structures.

Author contributions

PB, CB and MA jointly wrote this editorial; PB created the illustration.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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