
Linkage between Carnian Pluvial Episode and Wrangellia-Sambosan LIP

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Abstract

The Carnian Pluvial Episode (CPE) was a global environmental change and biotic crisis that occurred during the Carnian in the Late Triassic. The climate during the CPE was characterized by a short-lived period of extreme precipitation, and major extinctions of marine taxa occurred in the Carnian. The CPE is thought to have been caused by a large igneous province (LIP) magmatism, which resulted in the eruption of the Wrangellia flood basalts (FB) in northwestern Canada. In addition to the Wrangellia FB, Carnian oceanic basalts of an intraplate origin, including oceanic seamounts and plateaus, have been recognized in the Jurassic accretionary complex of the Sambosan Belt, Japan. These Carnian basalts originated in an open-ocean realm of the Panthalassa Ocean on the Izanagi Plate and were accreted along the East Asian subduction zone during the Late Jurassic. The contemporaneous emplacement of oceanic and flood basalts in the Sambosan and Wrangellia may suggest a single LIP origin for these basalts. Here, we present new geochemical (major and trace elements) and Sr isotopic data to constrain the origin of the basaltic rocks of the Sambosan Belt.

Whole-rock geochemical analyses of the Sambosan basalts indicate that these basalts are classified as alkaline basalts with high Na₂O concentrations. Discrimination diagrams based on least mobile elements suggest that the Sambosan basalts are analogues of the within-plate basalts (WPB). In the Nb/Yb-TiO₂/Yb diagram, these basalts are mainly lie within an OPB array with high TiO₂/Yb and Nb/Yb ratios, which may indicate that these basalts are derived from a LIP magmatism. Based on the REE composition, the Sambosan basalts are classified into a light rare earth element (LREE)-enriched group (Type1; (La/Sm)_n=2.1-3.3) and a relatively LREE-depleted group (Type2; (La/Sm)_n=0.7-1.3). The (La/Sm)_n-(Gd/Yb)_n data of the Type2 basalts were formed by up to 5 % melting of garnet lherzolite with a primitive mantle composition, whereas the data for the Type1 basalts are plotted along the melting curve of garnet and these degrees of partial melting were 1%-5%, similar to that of typical ocean island basalts.

The Sr and Nd isotopic compositions of the Sambosan basalts indicate that they were formed from a depleted mantle source with no contribution from delaminated lower continental crustal material or recycling of subducted continentally derived sediments. In the ²⁰⁶Pb/²⁰⁴Pb-²⁰⁷Pb/²⁰⁴Pb diagram, most of the Sambosan basalts and the Wrangellia FB lie above the NHRL (North Hemisphere Reference Line). In addition, portions of these basalts have Pb isotopic compositions plotting on or near the 4.43 Ga geochron (age-corrected

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to 230 Ma) with depleted Nd isotopes and TiO₂ concentrations, which are consistent with the composition of an early depleted, non-chondritic reservoir. High ²⁰⁶Pb/²⁰⁴Pb and ²⁰⁷Pb/²⁰⁴Pb ratios with the occurrence of xenocrysts trapped by recycled mantle components of the Sambosan basalts could indicate the involvement of the recycled oceanic crust (like HIMU origin).

The similarity of the isotopic compositions of the Sambosan basalts and the Wrangellia FB suggests that these basalts were derived from a single LIP magmatism associated with a mantle plume source in a mid-oceanic setting of the Panthalassa Ocean in the Carnian. In addition to the Sambosan basalts, Carnian oceanic basalts of intraplate origin, including oceanic seamounts and plateaus, have been recognized in the Jurassic accretionary complexes of the Taukha Belt in Far East Russia. The lithologies, accretion ages, and faunal similarities between the Sambosan and Taukha belts clearly indicate the extent of the East Asian Jurassic subduction zone for ca. 3000 km. The geochemical characteristics of most of the Sambosan and Taukha basalts are consistent with emplacement from a plume-related mantle source in a mid-oceanic location, and the timing of basaltic volcanism in the Sambosan and Taukha belts is constrained to Ladinian? to upper Carnian. The contemporaneous emplacement of oceanic and flood basalts in the Sambosan Belt, the Taukha Belt, and Wrangellia suggests the existence of a Carnian Large Igneous Province (LIP) in the Panthalassa Ocean, which we tentatively term the Wrangellia-Sambosan LIP.

Keywords: Triassic, Carnian Pluvial Episode, Wrangellia, Sambosan, LIP, basalt, geochemistry