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Genesis and Distribution of Ultra-alkaline Magmatism within the East Antarctic Associated with the Kerguelen Plume Activity

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Alkaline magmatism is often associated with the initial or final stages of huge plume activity. The alkaline bodies are most often found within the boundary area of plume impact upon the continents. The initial stages of the Kerguelen-plume activity were 136-130 Ma ago and affected the continental margin of India, Australia and Antarctica (Frey et al., 2000; Olierook et al., 2016). The magmatism coincides with the opening of the eastern part the Indian Ocean. A number of dykes and sills of alkaline-ultrabasic composition were intruded at 130-115 Ma ago in the East Antarctic Shield in the Lambert Glacier area, located opposite the Kerguelen Archipelago (Andronikov, Foley, 2001), formation of which is supposed to be a plume associated. At very close time (117-110 Ma ago) within the Rajmahal province (India) ultrabasic-alkaline magmatism connected with low degrees of lithospheric mantle melting was appeared (Kent et al., 2002). Lambert Glacier is located in the central sector of the East Antarctic craton in the northern Prince Charles Mountains. The Lambert Rift system (including Lambert Glacier) is related to Mesozoic extension events and it inherited structures of Paleozoic grabens. The total length of the rift system exceeds 4,000 km of the same scale as largest the World rift belts (Golynsky, Golynsky, 2012). Gondwana reconstructions indicate that the Lambert graben corresponds to the orientation and length scale of Carboniferous-Permian rift compartmentalization. The Lambert graben represents an accommodation zone of a wide intracontinental rift that extended from Australia's North West Shelf, between India and Antarctica, to southern Africa (Harrowfield et al., 2005).

Jurassic-Cretaceous dikes, stocks and sills of alkaline-ultramafic rocks akin to kimberlite-rock clan are exposed in Jetty oasis and on the south shore of Radok Lake where they cut Meso-Neoproterozoic metamorphic rocks of the Beaver Complex, Permo-Triassic clastic sediments of the Amery Complex and Late Paleozoic subalkaline mafic dikes. On modern erosion level these stock-like bodies are represented by oval, rarely isometric shape with sizes ranging from 10x25 to 80x120 m; while dike body length reaches 180 m and up to 2 m width. Inner structure of the

stocks are composed by two, and sometimes three groups of alkaline-ultramafic rocks comprising the successive phases of intrusion (from early to late): 1) tuffaceous breccia (tuffisites), 2) alkaline picrites and melanephelinite, 3) polcenite (not always present). All these alkaline-ultramafic rocks contain a variety of mantle origin nodules, mainly peridotites, as well as numerous xenoliths of host Permian-Triassic sediments, Precambrian metamorphic rocks and quartz porphyry.

Early Cretaceous (118-117 Ma) Rajmahal-Sylhet basalts from the eastern India are probably connected with the initial stages of Kerguelen-plume manifestation (Srivastava, Sinha, 2007). In the eastern and NE part of India alkaline and carbonatite complexes are widely developed, as well as ultrapotassic dikes and sills to the west of the Rajmahal Traps within the coal deposits of Damodar province. These ultrapotassic rocks could be classified as lamproites and consist of olivine, mica (phlogopite-biotite), diopside, amphibole, Cr-spinel, K-feldspar, carbonates (calcite, Fe-dolomite), Sr-apatite, Nb-rutile, Mg-ilmenite, chlorite, serpentine, silica and iron oxides in different proportions (Chalapathi Rao et al., 2014).

The alkaline-ultramafic rocks from Jetty oasis differ in higher MgO, Al₂O₃ and TiO₂ than ultrapotassic rocks of the eastern India, but in K₂O, SiO₂ and FeO they are similar that is revealed a close ultrapotassic type of these magmas with the same fractionation and mineral phase accumulation. Jetty oasis alkaline-ultramafic rocks are characterized by presence, up to 1-5%, of xenogenic olivines (Fo: 91-92), obviously mantle genesis, and by relatively high dispersion in olivine compositions from Fo₉₀ to Fo₇₆. Both rocks are characterized as well by varying potassium content and high loss of ignition and CO₂ concentrations. Variations in CaO from 9 to 23% reflect the content of carbonate minerals. CO₂ increase is correlated with Th, Ba, Pb, U and other lithophile elements growth and reflects the process of secondary changes observed.

The lithophile element distribution in the alkaline-ultramafic rocks of Jetty oasis and Jharia and Raniganj ultrapotassic intrusives close to each other and have a high mantle-normalized ratios: (La/Yb)_n = 62, (Gd/Yb)_n = 5.8,

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$(\text{Th/Nb})_n = 4.7$, $(\text{La/Nb})_n = 2.2$. All studied samples from Jetty oasis have a distinct Zr, Hf and Pb negative anomalies and a variable Nb anomaly as well as India lamproites. The preferential enrichment of incompatible elements compared to the heavy rare earth reflects the possible presence of garnet in the melting source, while Zr and Hf negative anomalies reflect possible rutile presence. Based on Sr-Nd isotopic data it should be noted that Indian and Lambert alkaline rocks are close in $^{87}\text{Sr}/^{86}\text{Sr}_i$: 0.7045-0.708, while the latter are characterized by less enriched Nd-isotopic composition reaching values of $^{143}\text{Nd}/^{144}\text{Nd}_i$ 0.51235-0.51270 (cf. Indian lamproites: 0.51226-0.51237).

Thus, the alkaline magma generation in the eastern India and Antarctica occurred within the periphery of the Kerguelen-plume at 120-110 m.y. ago. This is the time preceded or corresponded to the beginning of the plume activity in the Indian Ocean. Alkaline magmas originated by low degree melting of substantially heterogeneous lithospheric mantle, which was formed at the early stages of eastern Gondwana evolution. The influence of the plume on the first stages of activity affected this mantle and metasomatized it by penetrating melts which were often enriched in volatile components. Subsequent high temperature plume impact could lead to the mantle melting and to incipient alkaline and carbonatite magmas appearance within Lambert and Rajmahal regions.

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