Proterozoic oceanic arc and growth of Rodinia: Tectonic evolution of Natal Metamorphic belt, South Africa

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Grenvillian Natal Belt (NB) is located in the eastern part of South Africa. NMP has been thought as one of the juvenile continental fragments of the first super continent Rodinia. We interpret the NB as an obducted intra-ocenic arc section. The Tugela terrane would be an accretionary complex composed of intra-oceanic arc igneous rocks together with suprasubduction zone ophiolites and accreted oceanic island basaltic rocks. "Mandleni Oceanic island" once built on a foundation of oceanic crust of the Tugela ocean (Jacob et al., 1997) accreted to the Natal arc during closure of the Tugela ocean separating the Natal arc from the Kaapvaal craton. The Mzumbe and Margate terranes are interpreted as exposed middle to lower crust of the Natal arc.

Grenvillian (~1.1 Ga) Natal Belt (NB) is located in the eastern part of South Africa. It is a part of the Proterozoic Namaqualand-Natal mobile belt surrounding southern margin of the Kaapvaal craton. NB has been thought as one of the juvenile continental fragments of the first super continent "Rodinia". NB is divided into three terranes, each of them has a distinct structural, lithologic, and tectonic characteristics. They are from north to south, Tugela, Mzumbe, and Margate terranes. The Tugela terrane has long been interpreted as an ophiolite complex obducted onto the Kaapvaal craton, while the Mzumbe and Margate terranes has been thought as accreted arcs. The Tugela terrane is composed of four separated nappes; Nkomo, Madidima, Mandleni, and Tugela nappes (Matthews, 1972). In the Nkomo and Madidima nappes, metamorphosed sedimentary rocks are predominant lithologic units, while the Mandleni and Tugela nappes consist of mainly mafic-ultramafic meta volcanic rocks. The Tugela nappe consists two structurally distinct slices, Manyane and Tuma slices. The former is separated by the Tuma slice by thrust faults. The Manyane slice consists predominantly of amphibolites and subordinate amounts of metamorphosed gabbroic rocks.

We integrate field, geochemical and petrographic data to obtain protolith interpretation of the metamorphic rocks in the Tugela and Mandleni nappes. Geochemical characteristics of high Mandleni amphibolites in the Mandleni nappe are indicative of their derivation from basaltic protoliths formed under tectonic environment similar to the present day oceanic islands (Mandleni Oceanic island). Amphibolites in the Dulumbe paragneiss unit is identified as metamorphosed low-K arc tholeiitic basalts. The present data suggest that the Manyane amphibolites were derived from low-K tholeiitic basaltic rocks which are chemically similar to those distributed in the IBM arc. The Tuma slice is composed of metasedimentary rocks with subordinate amounts of basaltic pillow lavas. Lithologic characteristics of the Tuma rocks imply that they are parts of metamorphosed accretionary complex formed in subduction zone. The data collectively suggest that the Tugela terrane is composed of several accreted oceanic terranes formed under different tectonic settings.

The Kotongweni tonalitic complex consists of extensively deformed gneissose tonalitic and gabbroic rocks. It was intruded into amphibolites of the Manyane slice and extensively deformed, suggesting its emplacement prior to the obduction of the Tugela nappe onto the Kaapvaal craton. Geochemical features suggest that the Kotongweni tonalite is the M-type granitic rocks, being similar to the Phanerozoic Tanzawa tonalite occurring in the IBM arc.

Combining the present data with data formerly reported, we interpret the NB as an obducted intra-ocenic arc section (Natal arc). The Mfongosi and Ntingwe groups have been interpreted as shelf sediments deposited on the passive margin of Kaapvaal cratonic continent. This suggested that polarity of subduction would be southward (from Kaapvaal toward Natal arc). The Tugela terrane would be an accretionary complex composed of intra-oceanic arc igneous rocks together with suprasubduction zone ophiolites and accreted oceanic island basaltic rocks. "Mandleni Oceanic island" once built on a foundation of oceanic crust of the Tugela ocean (Jacob et al., 1997) accreted to the Natal arc during closure of the Tugela ocean separating the Natal arc from the Kaapvaal craton. The Mzumbe and Margate terranes are interpreted as exposed middle to lower crust of the Natal arc, and the Oribi Gorge Suite was probably formed by lower arc crustal anatexis induced by asthenosphere injection into a base of lower crust after the Natal-Kaapvaal collision and subsequent slab failure.