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Petrogenesis and Tectonic Significance of An Early Paleoproterozoic High-Mg Boninite-Norite-Diorite Suite of Rocks from the Bastar Craton, Central India

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Mafic/ultramafic rocks derived from high siliceous (high -Si) high magnesium (high-Mg) mantle melts are an important feature observed during early Precambrian. They provide much important geological and petrological information to understand mantle evolution and compositions. A wide variety of such high-Si high-Mg rocks is known and thought to be emplaced in a specific tectonic framework; however, in some cases, different tectonic settings have also been suggested. This includes high-Mg norite, siliceous high-Mg basalt (SHMB), boninite and high-Mg diorite. Early Paleoproterozoic high-Si high-Mg intrusive as well as extrusive mafic rocks (boninite-norite-diorite suite), emplaced in an intracratonic rift setting, from the Bastar craton, central India have been investigated to understand their origin and tectonic significance. On the basis of field relationships, available radiometric metamorphic age and global occurrence of boninite-norite magmatism, it is believed that they were emplacement at ca. 2.4-2.5 Ga (Early Paleoproterozoic). Geochemically they have high SiO2 (51.32-55.29 wt%), high MgO (8.20-15.42 wt%), low to moderate TiO2 (0.38-1.11 wt%) contents, which, in general, classify them as high-siliceous, high-magnesium basaltic rocks (SHMBs). The high-Si high-Mg nature of these rocks is also evident from their CIPW normative compositions as they contain quartz and appreciable amounts of pyroxene (both diopside and hypersthene). However, this geochemical range also overlaps with boninite, high-Mg norite and high-Mg andesites. The observed geochemical data definitely distinguish them from komatiite and picrite as these two have high-magnesium and low-silica values. Mg number (Mg#; between 62 and 81), Cr (384-1290 ppm) and Ni (137 -357) concentrations are high suggesting their derivation from mantle melts. Few samples have relatively high TiO2, Fe2O3, CaO and Zr values than other samples, which are, therefore, classified as high-Mg diorites. On the whole, studied high-Si high-Mg rocks are classified into three distinct varieties: high-Mg norites, high-Ca boninites and high-Mg diorites.

Nd-isotope data indicate that the high-Mg norite and the high-Mg diorite samples have almost similar 143Nd/144Ndinitial ratios, whereas high-Ca boninite samples show lower 143Nd/144Ndinitial ratios. Observed geochemical and isotopic features suggest that the identified three types have different petrogenetic histories. Therefore, suggested that the high-Mg norite and high-Mg diorite samples are derived from melts originated from a similar mantle composition, different from that responsible for the high-Ca boninite samples. The TDM model ages also support this inference. The high-Mg norite and the high-Mg diorite samples show younger TDM model ages, between 2565 Ma to 2970 Ma, when compared with those for the high-Ca boninites (from 3395 Ma to 3612 Ma). Although geochemical and Nd-isotopic characteristics of the studied rocks show some indication of crustal contamination, however possibility of mantle metasomatism through some ancient subduction event cannot be ignored. Ni–Zr petrogenetic models suggest that the high-Ca boninite rocks may have crystallised from a magma generated by comparatively high percentage of melting of a lherzolite mantle source, whereas magmas responsible for the other two varieties are originated by low percentage of melting of a similar mantle source. Further, the high-Ca boninites are most likely derived from the Whundo-type mechanism during an Archean subduction process, whereas the other two types are products of interaction of subduction-modified refractory mantle wedge and plume around the Neoarchean–Paleoproterozoic boundary. It is important to note that a number of large mafic magmatic events (LIPs) induced by mantle plume heads took place at the end of Archean and thereafter (2.6-2.2 Ga. This includes a number of high-Mg norite-boninite events. It should also be stressed that a number of ancient cratons were together at the end of Archean and across the Archean-Proterozoic boundary as a supercraton and the breakup history of these Archean supercraton may be linked to the associated LIPs.

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