# Structure, Petrography, Geochemistry and Geochronology of Gabbroic and Associated Granitoid Rocks in Parts of the South Delhi Fold Belt, Rajasthan, India: Implications for tectonic evolution

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## Abstract:

In the north-western Indian shield, the South Delhi Fold Belt (SDFB) of Proterozoic ageis trending NE-SW. The SDFB is juxtaposed with the Marwar craton along its western margin through the Phulad Shear Zone (PSZ).The PSZ is described as a terrane boundary shear zone that separates the SDFB to the east and the Marwar craton to the west. The PSZ has developed in a ductile transpressional regime with a top-to-the-NNW reverse movement around ~820 Ma. Within the SDFB, there is a substantial occurrence of isolated gabbro rocks and ~1 Ga granites extending in an NE-SW orientation, mirroring the alignment of the PSZ and the regional trend of the SDFB. The origin of these gabbro rocks has been a subject of intense debate, and the ~1 Ga granites from the SDFB are often correlated with the assembly of the Rodinia Supercontinent.The present study integrates field observations, petrology, geochemistry, and geochronology of the gabbro and ~1Ga granites of SDFB that occur in a 6-15 km wide linear belt extending for more than 200km.

The gabbro and the granite rocks occur as isolated patches along a linear belt and are variably deformed. Detailed investigations reveal synchronous foliations in the gabbro rocks, granites, and mylonites within the PSZ, indicating a common stress regime. Petrographic examinations were conducted on all the sampled gabbro and granite bodies along the fold belt. The gabbro rocks exhibit igneous assemblages with notable metamorphic imprints. The gabbro shows a prominent development of solid-state foliation, characterized by the preferred orientation of amphibole and plagioclase. The gabbroic rocks depict the replacement of primary minerals by amphibole and garnet.In the granites, the replacement of primary minerals appears to have occurred in two stages in all the separated granite bodies. Initially, amphibole was replaced sequentially by an epidote–titanite–quartz symplectite, followed by the formation of garnet. The euhedral garnet grains and titanite coronas are post-tectonic relative to the regional fabric, whereas the symplectite assemblage formed during deformation (PSZ

formation).Geochemically, these gabbro rocks exhibit a tholeiitic composition with flat HREE trends, whereas LREEs display a wide range of distributions from N-MORB to E-MORB. Geochemically, the granites are ferroan, calc-alkalic and metaluminous. Granite discrimination diagrams confirm A-type, further classified as $A_2$ type granite.Observations revealed a bimodal magmatic composition in the SDFB, encompassing both gabbro rocks and A-type granite. Both, these gabbroic and granite rocks show within-plate signatures in their respective tectonic discrimination diagrams, indicating extension-related magmatism. U-Pb zircon dates from the gabbro rocks indicate a magmatic Concordia age of 983.4 ± 6.0 Ma, while the granites indicate a magmatic Concordia age of 970.7 ± 2.9 Ma, overprinted by a metamorphic Concordia age of 824.5 ± 5.3 Ma. The later age coinciding with the NNW reverse sense of movement of the PSZ. Thus,it is suggested that the gabbroic and granitic rocks formed during crustal thinning at ~980-970 Ma, followed by the solid-state exhumation of the rocks that occurred at 820Ma, coinciding with PSZ formation.

By integrating field relations, petrography, geochemistry, and geochronology of the studied gabbroic and granitic rocks, the possible tectonic model suggests that crustal thinning occurred due to the rollback of a subducting oceanic plate. This process facilitated mantle upwelling and the formation of basaltic magma, which accumulated in the lower crust. Heat flow from the upwelling mantle and crystallizing mafic phases caused significant partial melting in the continental crust, resulting in the formation of gabbro through mafic magma emplacement and granite through crustal melting. The oldest reported age of the basement rocks of the Marwar Craton, dated to ~880 to 860 Ma, suggests that it sutured with remaining India around 820 Ma. The exhumation of the gabbro and granitic rocks occurred during the suturing of the Marwar Craton with the SDFB along the Phulad Shear Zone around 820 Ma.

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