# Geochemical and isotopic characteristics of the Amgaon Gneissic Complex and Tirodi Gneissic Complex of Central Indian Shield: Constraints on Precambrian crustal evolution

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The Central Indian Tectonic Zone (CITZ) is an important ENE-WSW trending continental scale tectonic feature in the Central Indian Shield region. Bundelkhand craton of northern central Indian shield and Bastar, Dharwar and eastern Singhbhum craton of southern central Indian shield have been accreted along the CITZ during proterozoic age. CITZ is traversed by numerous lineaments /shear zones among which Son-Narmada north Fault(SNNF), Son-Narmada South Fault(SNSF) Gavilgarg- Tan Shear zone (GTSZ), and Central Indian Shear (CIS) are prominent. The Amgaon Gneissic Complex (AGC) represents the basement rocks south of the CITZ and Tirodi Gneissic Complex (TGC) forms the basement for Sausar Supracrustal Belt which are exposed south and north of CIS.

Lithologically both AGC and TGC consist of granite-gneiss-migmatite assemblages, with vestiges of TTG suite ranges from trondhjemitic to granitic composition, the minor components includes the amphibolite, metabasalt, quartzite, BIF, kyanite-sillimanite and garnet-staurolite schists. In the major element and normative plots the AGC and TGC are granite to granodiorite in composition and predominantly calc-alkaline. A/CNK verses A/NK and A/CNK verses $SiO_2$ diagram shows metaluminoums nature of AGC while TGC shows both metaluminoums to peraluminous nature.

The AGC granitoids are classified into three groups based europium (Eu) anomalies as i. Group-I, samples with no Eu anomaly; ii. Group-II, samples with distinct negative Eu anomaly; iii. Group-III, samples with distinct positive Eu anomalies. In Group-I and Group-III rocks compatible behavior of HFSE probably indicate the fractionation of a titanomagnetite phase or zircon and the smooth patterns shown by the HFSE and HREE also indicates the retention of the heavy accessory phases with in the system owing to the high viscosity. The relatively low HREE and HFSE content in the Group-III samples require the garnet and amphibole to be an essential part of the residue.

Group-II samples indicate that these granitoids were derived from a LILE enriched source. The large negative Sr, Ba and Eu anomalies requires the presence of plagioclase in the residue and a relatively small Nb anomaly indicates presence of minor amphibole during melting. The high Zr concentration indicates absence of any significant fractionation of zircon thus implying the crustal or shallower origin for the Group-II rocks.

While the TGC are different from the AGC on the basis of Eu anomaly and enrichment of LREE, LILE and depletion of HREE, HFSE. The positive Eu anomalies components of TGC are less in number and not very prominent than ones seen in the Amgaon gneissic complex.

Group-I sample AG-01 has youngest model ages as it has $T_{DM}$ and $T_{CHUR}$ model ages of 2549 and 2226 Ma respectively. Group-II samples clocks the oldest ages for both $T_{DM}$ and $T_{CHUR}$ in AGC. In this group AG-02 with $T_{DM}$ (3396 Ma) and $T_{CHUR}$ values of 3160 Ma bears oldest amongst the AGC granitoids. Other two samples GS-17 and GS-32 have $T_{DM}$ model ages of 3106 and 3072 Ma, with $T_{CHUR}$ values of 2839 and 2813 Ma respectively.

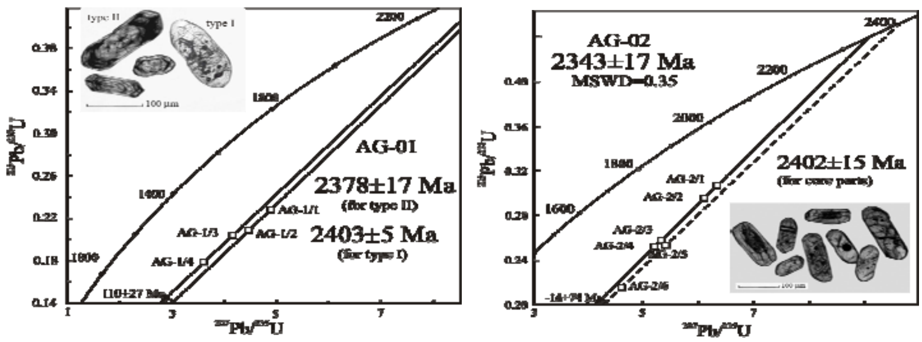
The Group-III sample GS-45 shows the oldest ages for the group with $T_{DM}$ age of 2974 and $T_{CHUR}$ age of 2684 Ma, whereas another sample KP-01 from same locality shows a difference of ~200 Ma, as it has $T_{DM}$ age of 2709 Ma and $T_{CHUR}$ age of 2337 Ma, thus it becomes the youngest representative of the group. Sample no GS-6 which has an extreme negative $\varepsilon_{Nd}$ value of -39.35 shows a relatively young age of 2862 Ma for $T_{DM}$ and $T_{CHUR}$ age of 2619 Ma.

The evolution curves of AGC samples with respect to those of CHUR and DM indicate that the AGC rocks were derived from an enriched source which had lower Sm/Nd and lower $^{143}Nd/^{144}Nd$ ratio. The $^{143}Nd/^{144}Nd$ ratios of the AGC samples when compared to the present day value of enriched mantle values of EM-I (<0.5112) and EM-II (0.5121), clearly indicate their derivation from EM-I type source. The distinction between the proposed groups is clear as Group-II samples show evolution from a more enriched mantle source than Group-I and Group-III samples.

Isotopic data indicate that the crust in the Central Indian shield had started forming from early Archean period. Samples of Groups-I and Group-III evolved slightly earlier when the precursors were dominantly mafic with garnet and amphiboles. Group II samples appear to have formed when the crust had already differentiated in Femic and Sialic components i.e. the crust had thickened considerably to allow the shallower protoliths to have feldspars as stable phase to cause the observed negative Eu anomaly in these rocks.

In sample AG-01 (Group I) there are three zircon generations: i. short prismatic rounded colorless grains with lower U contents (250-400 ppm), which have an age of 2403±5 Ma; ii. large brown long-prismatic better preserved grains with higher U contents (1100-1300 ppm) and U-Pb age of 2378±17; iii. prominent metamorphic rims on grains of the second generation. Zircons of the first generation with lower U content are typical for magmatic zircon from tonalities, while brown zircons of the second generation are probable the result of fluid influence from young granitic intrusion.

In sample AG-02 (Group II) Zircons are represented by brown transparent short to long prismatic grains up to 300 mμ in size. Half of grains from the coarse fractions have inherited cores. These zircons have been studied in alcohol and grains with visible cores have been separated and subsequently air abraded. Another fraction was subjected to two-step chemical dissolution. The main generation of zircons has U-Pb age of 2343±17 Ma, which reflects an age of magmatic crystallization of initial granites, while cores have preliminary U-Pb age of 2402±15 Ma, but probably they are older, since there is a certain input of rim age.




The Depleted Mantle Model ages ($T_{DM}$) calculated based on bulk rock from Amgaon and Betul area clearly indicate that the protoliths for the AGC and TGC were derived from enriched mantle sources and/or they had long crustal residence period prior to the generation of these gneissic rocks. The $T_{DM}$ ages, indicating extraction of the protoliths from the mantle sources, varies from 3319 to 2535 Ma in the case of AGC and from 2503 to 2118 Ma for the TGC. U-Pb age of some TGC components are 2056±07 Ma and 1506±11 Ma. Which suggest the basement rocks exposed north of Central Indian shear (TGC) and south of the Central Indian shear (AGC) appear to have evolved separately and have independent geological history.