ABSTRACT

Title- Origin and evolution of high aluminous rocks from parts of the Precambrian North Singhbhum Fold Belt, East Indian Shield

Index no- 149/13/Geol.Scs./22

Origin and evolution of the highly aluminous kyanite quartzite, reported only from a few metamorphic fold belts of world, are not properly understood. In the arcuate Palaeoproterozoic North Singhbhum Fold belt (NSFB) of the East Indian shield, the Singhbhum Shear Zone (SSZ) with its rich Fe-Cu –U –phosphate deposits separate the metavolcano-sedimentary sequence of Lower and Upper Dhanjori Fm. from the metasedimentary sequence of Chaibasa Fm. The kyanite quartzite occurs as isolated pods all along the hanging wall side of the SSZ at the immediate contact with the Chaibasa Fm. Both banded (defined by centimetre to decimetre thick alternate layers rich in kyanite and quartz) and massive (without any compositional banding) variety of kyanite quartzite are noted. The rock shows wide variation in terms of kyanite/quartz ratio~~n~~, shape and mode of occurrence of kyanite grains. The kyanite quartzite is intensely deformed and commonly replaced by muscovite. Both kyanite and quartz show crystaloplastic deformation. The stretched grains of kyanite and quartz define a planar fabric that conform the shear fabric in the SSZ. Fabric parallel growth of muscovite after deformed kyanite produce alternate muscovite-and kyanite quartz rich bands. The planar fabric swerves around least deformed lenses showing randomly oriented kyanite grains. In places, kyanite-quartz veins with kyanite grains at nearly perpendicular to the vein wall cuts across the regional planar fabric. The vein itself shows deformation suggesting that these veins were formed during the deformation in the SSZ. These veins are interpreted as fluid conduits in which Al and Si precipitated from the fluid. Relative to the Primitive Mantle compositions, the compositions of the studied muscovite poor kyanite quartzite show elevated LILE, HFSE and LREE with a prominent Nb and Pb anomaly. In terms of REE and most of the HFSE concentrations the rock shows remarkable similarity with the metasedimentary rocks of the Chaibasa Fm. Combining the bulk chemical attributes, high alteration indices (CIA~98, CIW~99, PIA~99, AAAI~94) and the narrow $\delta^{18}O$ values (7-7.7 per mil relative to SMOW) of the kyanite, it is proposed that the advanced argillic alteration of the pelitic rocks of the Chaibasa Fm. This alteration process predated the ~1.6 Ga old shearing and accompanied metamorphism/metasomatism in the SSZ. Extant geochronological data suggest that the alteration process was associated with the formation of the protoliths of the hydrothermal Cu-Fe sulphide deposits at ~1.8 Ga in the SSZ. This study, therefore, demonstrates contrasting behaviour of Al during fluid-rock alteration.

Textural modelling study suggests that muscovite was formed during infiltration of K during the ~1.6 Ga tectonothermal event in the SSZ. Owing to its highly aluminous bulk compositions and variation of the composition of the infiltrating fluids, the kyanite quartzite develop many exotic minerals during the ~1.6 Ga tectonothermal event in the SSZ. Infiltration of Fe-Mg bearing fluid developed metasomatic chloritoid after kyanite that is hitherto not reported from metamorphic belt. Numerically and thermodynamically computed phase diagrams in the P-T and μ_{FeO} - μ_{SiO2} space (at different P-T conditions) constrain that the metasomatic chloritoid developed at 6 ±1 kbar and ~ 500°C along a geothermal gradient~80°C/kbar. Fe and Mg were likely to be transported in the form of $FeCl_4^{2-}$ or $FeCl_3(H_2O)^-$ complexes. Solid volume change of the metasomatic reactions (during formation of muscovite and chloritoid) helped create secondary porosity driven permeability for the metasomatic fluids. The replacement of kyanite by florencite suggests that LREE and P was transported in REE-Phosphate complex in the metasomatic fluid. Sequential infiltration of P- and Mg-rich fluid in develops augelite and lazulite in the banded kyanite quartzite at P-T conditions at which metasomatic chloritoid and muscovite were formed. A fluid–rock ratio of only 0.38 is sufficient to completely convert kyanite to augelite. The P-T conditions of 6 ±1 kbar and ~500°C deviates from recorded thermal perturbation with respect to the steady state geothermal gradient that is estimated for Proterozoic period. The observed thermal perturbation in the SSZ and the adjoining lithologies is explained by burial of the exposed section of the crust beneath a continental thrust sheet of ~25 km at ~1.6 Ga tectonothermal event presumably in a continent-continent collision setting. This event was preceded by a period of extension, presumably at ~1.8 Ga, during which the protolith of the metavolcanics, metasedimentary rocks of the NSFB were formed. In the same extensional event, the protoliths of the Cu-Fe-sulphide ores and accompanying advanced argillic alteration that led to the formation of the protolith of the kyanite quartzite in the SSZ were formed.

Maitrayee Chakraborty 24/01/23

Maitrayee Chakraborty

(Signature of Supervisors)

Pulak Sengupta 24/1/23

Prof. Pulak Sengupta
Department of Geological Sciences
Jadavpur University
Kolkata-700032

Professor
Dept. of Geological Sciences
Jadavpur University
Kolkata-700032

Sanjoy Sanyal 24.01.2023

Prof. Sanjoy Sanyal
Department of Geological Sciences
Jadavpur University
Kolkata-700032

Dr. Sanjoy Sanyal
Professor
Department of Geological Sciences
Jadavpur University
Kolkata: 700032, India