Abstract

The calc-silicate rocks of the study area belong to the Lunavada Group which is a second youngest group of the Aravalli Supergroup forming an extension of the Southern Aravalli Mountain Belt (SAMB), which occupies the NE part of the Gujarat state.These rocks comprise youngest formation of Lunavada Group known as 'Kadana Formation' having Mesoproterozoic age.The Godhra granite rims north-west as well as south-east margin of the Lunavada Group. F_1, F_2 and F_3 folds are recorded in and around Lunavada region. These rocks occur as discontinuous lensoidal bodies within quartzite-metapelite intercalations and exhibit light to dark grey colour and fine to medium grained nature. These rocks show star shaped or unoriented amphibole needles and maculose structure. Hornfelsic/granofelsic texture as major texture along with secondary porphyro-poikiloblastic texture and typical mineral assemblage as, act + di + qz + ttn + cal ± mc ± bt ± pl ± ep ± scp ± chl ± ank along with minor apatite, zircon and ilmenite is observed within these rocks. Certain reaction textures, viz. replacement of ankerite by diopside (salite) as well as actinolites having inclusions of diopside are seen. Similarly, with the help of a table depicting time relationship between crystallization and deformation, it is postulated that the minerals, i.e. actinolite and scapolite got developed on account of contact metamorphism caused by syn-to-post D_3 Godhra granitic intrusive event.Calcic amphibole composition ranges from magnesio-hornblende to actinolite as per EPMA data. Clinopyroxene composition is mainly salitic. Biotites are inclined towards phlogopitic composition. Scapolites are Cl-absent calcic-rich meionites. Moderately negative Eu anomaly is exhibited by these rocks thus suggesting post-archean sedimentary protolith. Presence of calcareous sandstone with small and varied amounts of clay as a protolith is supported by CaO, Al_2O_3 and FeO + MgO ternary diagram, positive correlation observed between Al_2O_3 and most of the trace elements along with Na_2O and K_2O as well as by Al-Zr-Ti diagram. Moderate amount of alteration is experienced by sedimentary protolith of these rocks. Felsic source is indicated by Th/Sc values >0.79 and is supported by enrichment of these rocks in incompatible elements like Th, Zr and La as well as by Th/Co and La/Sc plot. Similarly, Sc-Th-Zr/10 diagram indicates that the sediments were deposited on active continental margin. An average temperature, 634ºC is estimated at peak metamorphism with the help of Ti-in-biotite thermometer; similarly, the pressure value of 1.1 Kbar is derived by Silica-Ca-tschermak's-anorthite (SCAn) barometer. Isobaric T-X (CO_2) pseudosections were modelled in the KNCFMASTCH system using Perple_X software (version 6.8.1) at assumed 1kbar pressure and fluid composition range as 0-1 for X(CO_2).

Chemographic projections portrayed the development of minerals within a rock as the metamorphism progresses. By taking all metamorphic conditions of calc-silicates into account the 'Hornblende-hornfels' facies of contact metamorphism is concluded. Evolution of Lunavada basin during middle phase of Aravalli Geological Cycle is postulated which was an active margin stage and was having a Mesoproterozoic age. During this period accretionary orogenesis occurred followed by the process of crustal extension thus producing a back arc basin, i.e. the Lunavada basin. It was later intruded by arc plutons causing thermal metamorphism of the sediments deposited within and gave rise to the present day calc-silicates. Comparative petrogenetic studies of calc-silicates from Lunavada with those from other parts of the SAMB include calc-silicates from area in and around Champaner mainly.The calc-silicates of this area belong to the Khandia Formation of the Champaner Group, a youngest group of the Aravalli Supergroup and are also intruded by Godhra granite. These are grey coloured and fine to medium grained rocks. The characteristic mineral assemblage observed is, dol + tr + di + scp + ttn + tlc + qz ± cal ± grt ± chl ± pl ± mc. EPMA studies reveal that the amphiboles of the calc-silicates from Champaner are having tremolitic composition as compared to those from the calc-silicates of Lunavada where chemical composition varies from magnesio-hornblende to actinolite. The clino-pyroxene of calc-silicates is totally diopsidic in case of Champaner region whereas the Cpx of rocks from Lunavada are more salitic. Geochemistry data revealed that the slight negative Eu anomalies are shown by calc-silicates of Champaner as compared to the moderate negative anomalies shown by calc-silicates of Lunavada. Protolith of the calc-silicates of Champaner is siliceous dolomite in contrast to the calcareous sandstone as a protolith for the calc-silicates of Lunavada. Mafic nature of provenance is indicated for calc-silicates of Champaner as compared to the felsic provenance of calc-silicates of Lunavada. Sediment deposition occurred within a range of tectonic settings,i.e. from continental island arc to active continental margin in case of Champaner calc-silicates in contrast to the Lunavada where deposition took place at an active continental margin setting only. Standard 1kbar pressure is considered for these calc-silicates at peak metamorphism as they lie within contact aureole and because of the lack of suitable thermometer, based on petrographic studies, temperature is assumed to be between 650° to 700°C. The pressure and temperature conditions suggest metamorphic facies as 'Pyroxene-hornfels facies' and is supported by phase equilibria studies also.