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Tectonometamorphic history and significance of a ca 1450 Ma event recorded in the Proterozoic succession from a part of the Pakhal Basin adjoining the Eastern Ghat Mobile Belt, South India

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The sedimentary rock sequences in the Proterozoic Pakhal basin in the southeastern part of peninsular India are known to be largely unmetamorphosed and locally deformed. However, the present study of the lithopackage in the southeastern fringe of the basin in the Yellandu area provides evidence of low to moderate scale multi-stage deformation and greenschist to amphibolite facies metamorphism besides a prominent ca 1450 Ma geological event. At least three prominent phases of deformation were inferred from penetrative small scale folds, refolded folds and their intersection besides overprinting of the earlier foliation in the Proterozoic successions of Pakhal Supergroup in the studied area. An attempt was made based on the technique of microstructural study to correlate phases of deformation with corresponding stages of growth of metamorphic minerals. The metamorphism is attributed to one of the major tectono-thermal events of the proximal Ongole Domain of the Eastern Ghats Granulite Belt. The earliest structure identified is represented by very tight to isoclinal folds (F_1) on bedding plane (S_0), with a pervasive axial planar cleavage (S_1). The attitude of the S_0 and S_1 varies from NE-SW to NW-SE due to folding. They have been affected by co-axial, open to tight, upright F_2 folds with axial plane striking NNE-SSW. As a consequence, the F_1 folds range from recumbent/reclined through inclined to upright type at different places. Both F_1 and F_2 are related to buckle origin. The latest structure in the area are upright, conjugate folds (F3) and kink bands with axial plane striking N-S, E-W and chevron folds with NW-SE striking axial plane. The F3 structure resulted due to longitudinal shortening during the last stage of deformation. Microstructural study of thin sections of these rocks shows that porphyroblasts of chloritoid, garnet, staurolite and andalusite have different growth relationship with the quartz–feldspar–mica (biotite–chorite) matrix. Garnet, andalusite and biotite exhibit at least two phases of growth. The first metamorphic (M1) event is pretectonic to D_1 deformation, the second metamorphic (M_2) event is syn D_1 (pre-D_2 phase) and the third metamorphic (M_3) event is post-tectonic with respect to D_2 deformation. Staurolite developed during M_1 stage shows close association with garnet[1] and andalusite[1] of this event. Dominant schistosity (S_1) swerves around the pre-D_1 porphyroblasts of garnet[1] and andalusite[1]. Chlorite[1] and biotite[1] define the S_1 schistosity which indicates the growth of these minerals during the M_2 event which is syn-D_1 deformation. Andulusite[2] and garnet[2] occur as porphyroblasts and show post-kinematic relationship with the S_1 schistosity. These porphyroblast are developed across the schistosity (S_1). The possible metamorphic reactions in M_1 phase as derived from textural relationship could be: Ctd + And[1] = St + Chl[1] and And[1] + Grt[1] + Bt[1] = Ms + St. Inclusion of staurolite and chlorite[1] grains within coarse porphyroblasts of andalusite[2] and biotite[2] suggest the reaction: St + Chl[1] + Ms = And[2] + Bt[2] + H_2O. Finally, replacement of the biotite and andalusite by medium grained randomly oriented muscovite[2] and chlorite[2] is inferred to be post-D_2 or syn-D_3 deformation. The possible reaction is Bt + And + H_2O = Chl[2] + Ms[2]. From EPMA data it is observed that the garnets are mainly almandine in composition (Alm-0.83, Sp-0.06, py-0.06, Gr-0.05) and the porphyroblasts display enrichment in the almandine component from core to rim. Estimates of the peak temperature of the metamorphic event

(M_1) in this sector of the Pakhal basin are in the range of 450^0C to 550^0C. The ca 1450 Ma EPMA date obtained from a monazite grain developed at the margin of garnet[1] possibly relates to the earliest phase of metamorphism (M_1) of the area.