Ductile deformation history in Laibid metamorphic rocks, Sanandaj-Sirjan Zone, Iran

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Sanandaj-Sirjan zone, in northeast of Zagros suture zone, is the metamorphic belt of the Zagros orogen which is metamorphosed during Late Mesozoic, as the active margin of the Neotethys subduction system. Since Late Cretaceous, oblique collision between Afro-Arabian continent and Central Iran micro continent resulted in dextral transpression and Poly-phase deformations of this zone.

Laibid area, northwest of Esfahan province, is situated in complexly deformed sub zone of the Sanandaj-Sirjan zone in which structurally exposed Permian metamorphosed rocks are separated from the younger Triassic-Jurassic metamorphic rocks by faulted boundaries. Cretaceous unites do not exist in the study area, but in southern most parts un-metamorphosed Early Cretaceous rocks rest on Jurassic metamorphic units over an angular unconformity. Field observations reveal the existence of 3 folding patterns, folded dikes, semi-ductile to ductile shear zones and also sin-tectonic granite intrusion. Hassan-Robat Alkali-porphyritic-granite is exposed in the eastern part of the area with the possible ages between post-Early Cretaceous to pre-Eocene. In this research, the focus is on ductile structures and their deformation history in the Laibid area.

Structural analysis of the folds reveals three deformation stages of a progressive deformation in this area. These folding patterns observed in all pre-Cretaceous metamorphosed unites, but not in Cretaceous rocks. The first stage includes tight to isoclinal folds, S0 ∥ S1, with the aspect ratio changes respectively from tall and short. Although their axial plane and fold axis orientations change due to other two folding stages, but they mostly have moderately dipping to the NE axial plane and moderately plunging fold axis to NW or SE. In the eastern part of the area the trend of F1 foliation changes around the Hassan-Robat granite. The second folding stage includes open to close asymmetric folds which have broad aspect ratio. This folding stage resulted in a dominant axial plane foliation affected all rock units. These folds commonly have low to moderate plunge axis and NW-SE axial plane trends. Finally, the third stage includes gentle to open upright folds with wide aspect ratio, E-W axial plane trends and gently plunge axis. Superposition of these fold generations caused in coaxial interference patterns.

Metamorphosed and metasomatized intermediate to basic dikes which cut thought the Permian metamorphic rocks are mostly outcropped in the central and eastern part of the Laibid area. Previous studies suggest post-Permian-pre-Late Triassic ages for them. Although these dikes have E-W to ENE-WSW trends, observation of their outcrops on the walls of Laibid marble mines indicates they are folded and boudined by the folding stages. Dikes are mostly parallel to axial plane foliations on these walls.

Semi-ductile to ductile shear zones exist in central and eastern parts of the area. In the eastern part, their foliation turns around the Hassan-Robat granitic pluton. Study of the shear sense indicators on oriented thin sections such as mica fishes, stepped fragmented grains, s-c and s-c' fabrics illustrates they all have top to the northeast sense of shear. Field observation and thin sections studies indicate shear zones affected the first folding stages.

It seems that during Late Jurassic, three folding stages consequently formed and passively rotated in a continuous deformation condition. Dikes are alternatively injected in to the extensional fractures and through the axial plane foliation and gradually deformed in to the folds, boudins, folded boudins, and boudined folds. Hassan-Robat granite intrusion and shearing events both must be occurred at least after first stage of folding.