On the relationship between antitaxial vein growth and deformation bands in fine-grained sandstone

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The formation of antitaxial calcite veins in sandstone and their kinematic evolution have received less attention, partly because of their complex growth with respect to wall rock. The modes of deformation in which these antitaxial veins nucleate and deform are still not well understood. For this purpose we have investigated complex network of antitaxial veins and associated shear bands in a hand specimen sample. Since, veins and shear bands accommodate volume gain and loss, respectively; therefore, systematic study of strain partitioning and kinematic track is developed, consistent with the deformation history of the rock under study. Three sets of antitaxial veins and one set of shear band have been recognized. Set 1 consists of veins that are truncated against younger veins and shear bands (Fig.1). Set 2 consists of all those veins that are oriented at low- to high- angle with respect to set 1 veins. These veins cut across set 1 veins or vice versa. This suggests that both set 2 and set 1 form synchronously. Internal geometry of both set 1 and 2 veins form calcite fibers that are asymmetric and interpreted to have developed by repeated growth of fibers, at least in two stages, in two directions (Fig. 1). Set 2 veins have shear sense opposite to that of set 1 veins. The fibers are smoothly curved from median to the margins and this geometrical relationship suggests that the change in the rotation of the kinematic axes was gradual. Power law relationship on length vs frequency of veins suggests that both set 1 and 2 veins propagated sequentially.

Shear bands cut set 1 and 2 veins and are categorized under set 3. These bands are evenly spaced, consist of pulverized/opaque material, parallel to each other and accommodated shearing. Veins belonging to set 4 are relatively thick and cross cut set 1, 2 and 3. The spatial distribution of set 4 veins is low as compared to set 1 and 2 veins. Micro-textural study shows that these veins are filled with blocky crystals of quartz or calcite and are different than set 1 and set 2 veins. At the margins of set 4 veins, asymmetric remnants of calcite fibers are preserved with distinct shear sense. This firmly suggests that set 4 veins initially formed as ‘antitaxial ‘veins with asymmetric fibers, however as the deformation progressed, new material in the form of either quartz or calcite intruded. Detailed fabric analysis of calcite fibers indicates that both set 1 and 2 veins dilated perpendicular to the wall rock and then subsequently sheared in opposite direction. Since, set 1 and 2 veins have an angle ranging between 60^{o} and 120^{o}, therefore, we propose that the stretching direction switched gradually with a maximum angle of 120^{o}. The margins of the veins show asymmetry and distinct shear sense, this further suggests that once formed, both sets 1 and 2 were subjected to shearing. These two sets were then subject to shearing followed by the formation of set 4 antitaxial veins.

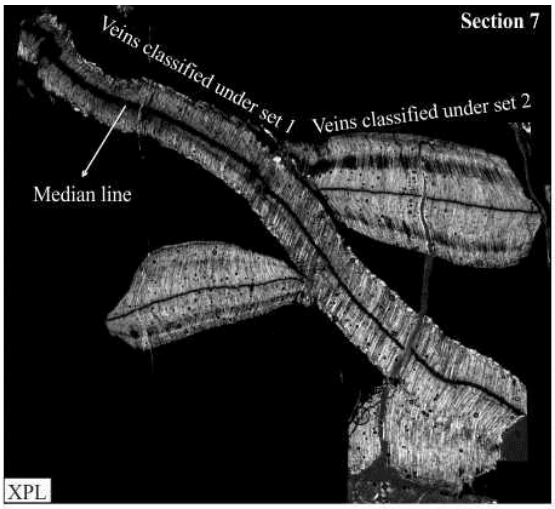

Fig. 1. Micrograph showing cross-cutting relationship between set 1 and 2 veins. In this particular case, set 2 is older. Note that the calcite fibers are continuous from wall to wall with a centered median line and designated as 'antitaxial veins. Base of the phot is 1.5cm.