Kinematics in the Sambagawa schist during a prograde stage inferred from inclusion fabrics in plagioclase porphyroblasts

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Subduction and exhumation processes of accretion complexes were accompanied by a large-scale ductile deformation, and hence it is possible to reconstruct the kinematic pictures based on microstructures in deformed rocks. In order to understand kinematics during the subduction (and hence prograde) stages of the Sambagawa schist, we have analyzed shape fabrics of epidote inclusions trapped in plagioclase porphyroblasts, which grew at the peak metamorphic conditions. Since epidote grain is elongated parallel to the b-axis, the b-axis fabric exhibits the shape preferred orientation. Since epidote itself is not ductile at the temperature conditions of Sambagawa metamorphism, it behaved as a rigid-rod and rotated during the whole rock deformation, forming shape preferred orientation.

Two epidote-amphibolite samples were collected from the oligoclase-biotite zone of the Sambagawa metamorphic rocks along the Asemi-River, and epidote inclusion fabrics in plagioclase porphyroblasts both on the XZ and YZ sections have been analyzed. Here, the X-, Y- and Z-axes denote the principal directions of finite strain in matrix epidote-amphibolite. For the first sample, on the XZ section, the inclusion alignment forms an internal foliation (Si) inclined at 45 degrees to the matrix foliation (Se), which is curved into the orientation parallel to the Se at the outer part of the Si, forming a S-shaped inclusion trace. The stereographic plots of the b-axes clearly lie on a great circle for both the inner and outer parts of the sharply bent S-shaped inclusion trace, respectively, defining a Si in each part. The maximum eigenvector of the b-axis fabric tensor indicates the mean lineation direction (Li). The obtained mean lineation direction (Li) is parallel to both the Y-axis of the matrix finite strain and the orientation of the rotation-axis (fold-axis) of the S-shaped inclusion trace. On the YZ section, the Si is also curved as a S-shape. However, the rotation axis is nearly oriented in the X-direction, and hence perpendicular to the Li, nearly parallel to the rotation axis on the XZ plane. For the second sample, on both the XZ and YZ sections, a Si is clearly defined, and curved. The Li is nearly parallel to the XZ plane. On the XZ plane, the rotation axis of the curved Si is nearly parallel to the Y-axis, and hence perpendicular to the Li. On the other hand, on the YZ plane, the rotation axis of the curved Si is nearly parallel to the Li, and hence perpendicular to the rotation axis on the XZ plane.

The following kinematics have been inferred from the above facts. The b-axis fabrics of epidote inclusions, where the rotation axis of the curved Si is perpendicular to the Li, initially formed (the first stage deformation). Later, since the flow direction was rotated by 90 degrees in the Si-plane, the rotation axis was also rotated by the same angle. This led to the formation of the b-axis fabric, where the rotation axis is parallel to the Li (the second stage deformation). Although the existent Li should have been rotated toward the new flow direction, the Li scarcely rotated because of a small strain of the second deformation. The reason for that the first deformation certainly preceded to the second deformation is that the curved Si formed by the first deformation was not twisted by the second deformation. While in the former sample the first deformation is seen on the YZ plane, in the latter sample, this is seen on the XZ plane. This fact indicates that the plagioclase porphyroblasts were rotated to various degrees between the different samples after the inclusion fabrics were trapped in these. Since the Sambagawa metamorphic rocks were formed and exhumed by the subduction of the Izanagi oceanic plate during the Cretaceous period, it is most reasonable to conclude that the above two rotation axes (flow directions) orthogonal from each other correspond to the subduction and exhumation related deformations, respectively