The geometrical relationship between the stretching lineation and the movement direction of shear zones

S. Lin and P.F. Williams
Department of Geology, University of New Brunswick, Fredericton, New Brunswick E3B 5H1, Canada

The internal structure of shear zones generally has monoclinic symmetry. The symmetry plane is perpendicular to the intersection of the shape fabric (S-foliation) and the shear zone boundary and contains the stretching lineation, the shear direction, and the poles to the S-foliation. It is the orthogonal projection of the stretching lineation on the shear zone boundary, not the stretching lineation itself, that is parallel to the shear direction. Unless the movement is truly strike-slip and the shear zone is vertical, the plunge of the shear direction is not equal to that of the stretching lineation. Qualitatively the point is obvious; what is not so obvious is that the magnitude of the potential error is likely to be significant, as is clear from a quantitative study.

A consistently shallowly plunging stretching lineation on a steeply dipping foliation in a shear zone is commonly interpreted as indicating strike-slip motion with a minor vertical component. This study shows that this may not necessarily be true. For example, the stretching lineation formed in a true strike-slip shear zone dipping 60° would pitch 16° (plunge 14°) on S-dipping 64°, if the angle between S and C is 30°. Movement on such a shear zone could be hundreds of kilometres. However, if the stretching lineation were correlated with the movement direction, there would be ca. 2.6 km dip slip for every 10 km strike-slip, and if there is no metamorphic change across the fault, we would conclude, perhaps erroneously, that the movement could be no more than 10 to 20 km. Faults with such geometry are known in the Canadian Appalachians.

Steeply plunging stretching lineations on steeply dipping foliations in shear zones are usually interpreted as indicating dominant dip-slip movement with only a minor horizontal component. However, this also may not necessarily be true. For example, sinistral reverse movement along a shear zone dipping 45° with movement direction pitching 45° (plunging 30°) would form a stretching lineation pitching 58° (plunging 52°) on a foliation dipping 69°, if the angle between S and C is 30°. Shear zones with such a geometry may be common in positive flower structures.

The stretching lineation and the S-foliation can be used to determine the shear direction if either the attitude or the strike of the shear zone is known. The true shear direction is parallel to the intersection of the symmetry plane and the shear zone boundary. The former is defined by the stretching lineation and the poles to the S-foliation. The latter, if it cannot be measured directly in the field, is parallel to the plane defined by the shear-zone strike and the pole to the symmetry plane.