Paleo temperatures, depths and stresses evaluated using calcite twinning paleopiezometry

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Mechanical twinning along an *e*-plane in calcite occurs if the resolved shear stress along the gliding direction of the *e*-plane exceeds a critical value, τ_c, which is around 10 MPa (Lacombe, 2010). Based on this twinning condition, it is possible to devise inversion schemes to determine non-dimensional deviatoric stress tensors from the orientations of *e*-twin lamellae (e.g., Etchecopar, 1984). The tensor is defined as the deviatoric stress tensor divided by τ_c. However, most of natural calcite aggregates have experienced two or more tectonic phases, which had different stress conditions. Even in such a case the non-dimensional deviatoric stress tensors can be determined from a heterogeneous data set, and the number of the tensors to be detected is evaluated using Bayesian information criterion (Yamaji, this session).
On the other hand, the mechanical twinning results in the simple shear, the amount of which can be evaluated from twin density (e.g., Groshong, 1972). Deformation experiments have demonstrated that the incremental strain increases effective τ_c value. Lacombe (2010) compiled the results of such experiments to show the relationship among temperature, strain and τ_c.
Once the τ_c value is obtained, the depth where the twinning occurred can be estimated from the differential stress determined from the twin data, because the critical differential stress is proportional to depth in the brittle upper crust. Assuming an appropriate geothermal gradient, the depth can be converted to temperature. Based on the relationship by Lacombe (2010) and the deviatoric stress tensors obtained from the data, it is possible to define and solve the simultaneous equations of temperature, depth, deviatoric stress tensor and τ_c.
This method was applied to a calcite vein in a Miocene graben, which was formed during the Japan Sea backarc opening. The preliminary results are introduced in the presentation.

Keywords: geothermics, stress, vertical movements, exhumation

