DEFORMATION MECHANISMS, CRYSTALLOGRAPHIC FABRIC AND RHEOLOGY OF QUARTZ-IRON OXIDE TECTONITES

Leonardo Lagoeiro – Departamento de Geologia da Escola de Minas – Univ. Fed. Ouro Preto – Brasil

Quartz-iron oxide tectonites are part of banded iron formations of proterozoic age, which occur in Quadrilátero Ferrífero Region, in Minas Gerais State, Brazil. These rocks are compositionally banded with alternated pure quartz and iron oxide-rich layers. The layering results from intense folding and transposition of an original banding in shear zones developed under greenschsist to lower amphibolite facies conditions.

A wide variety of microstructures are found in these rocks reflecting different modes of deformation. In low-strain domains magnetite is the predominant iron phase. Magnetite grains deforms in much the same way as the feldspar minerals do in lower greenschist metamorphic conditions. Microfracturing along crystallographically controlled planes is abundant. In higher-strain domains most of magnetite is transformed to hematite. The transformation involves two processes. The first consist of *in-situ* transformation to hematite along crystallographically controlled planes. The two phases share the same crystallographic plane, the octahedral plane {111} in magnetite and the basal planes (0001) in hematite. The other process consists in dissolution of magnetite along the magnetite / in-situ-transformed hematite boundaries and precipitation of new hematite platelets. In both processes newly formed hematite grains result in matrix composed of an aggregate of softer grains in contrast with the hard magnetite old grains. The transformation of magnetite to hematite induces strain localization in the iron formation rocks.

In highly sheared domains magnetite grains are rare or absent. Hematite grains are the main iron oxide phase. They deformed mainly by crystal plasticity and/or by pressure solution. Crystal plasticity deformation took place through basal (0001) slip. Due to the original orientation of the hematite grains (basal planes parallel to the macroscopic foliation) twinning is rarely found. Platy hematite grains dominate and are optically strain-free. The shape preferred orientation may not be an exclusively result of the crystal plasticity process. Strong evidences for pressure solution, such as small euhedral hematite grains in quartz pores facing the maximum elongation direction (X axis of the finite strain ellipsoid) suggest that hematite grains may have dissolved along their basal planes, normal to the maximum shortening direction (Z axis of the finite strain ellipsoid) and precipitated inside the pores of quartz grains in faces normal to the X axis. This, in addition to the slip in basal planes, accounts for the strong shape and crystallographic orientation observed in these rocks.

Quartz grains have a mode of deformation similar to those of hematite grains. Dissolution-precipitation and dislocation-creep are the dominant deformation mechanisms. However which mechanism predominates depends on the content of iron oxide minerals. In pure quartz layers, quartz grains deform mainly by dislocation creep. Microstructures and crystallographic fabric suggest that dislocation-creep occurs in the transition of regime 2 to regime 3 of Hirth and Tullis. In iron-oxide rich layers, microstructures and crystallographic fabric are indicative of dissolution-precipitation creep. Quartz grains are easier to dissolve when they are in contact with iron oxide minerals and their *c*-axes are close to the direction of maximum shortening (Z-axis). Precipitated quartz grains have a high aspect ratio (up to 1:10) and *c*-axes oriented parallel to the direction of maximum elongation (X-axis).

Experimental studies in quartz-iron oxide tectonites also demonstrate that quartz and hematite behave in similar ways. Both show a strong grain shape preferred orientation. Quartz grains deform by recrystallization-accommodated dislocation creep and hematite grains by slip on basal (0001) planes. Hematite grains behave in a very similar manner to the phyllosilicates despite of their contrasted crystallographic structures.