# Petrographic textures and heat conduction in hornfelses of the Bushveld contact aureole, eastern Transvaal area, South Africa.

# Yasunari Kaneko[1], Takashi Miyano[2], Kohei Mizuno[3]

[1] Geoscience, Univ. Tsukuba, [2] Inst. Geosci., Univ. Tsukuba, [3] VBL, Univ. Tsukuba

Pelitic hornfelses in the contact aureole of the Bushveld Complex show several characteristic textures; (1) ghost structure in poikiloblastic andalusite and staurolite, (2) pseudomorph consisting of quartz, relic biotite, muscovite, and Fe-Ti-oxide after earlier biotite, (3) pseudomorph consisting of muscovite, biotite, quartz, Fe-Ti-oxide, and/or pinite after cordierite, and (4) sillimanite enclosed with andalusite. These textures may be explained with a model of sheet-like magma intrusion and heat conduction from the intrusive center toward the surrounding rocks. Whether the texture is retrogressive and/or progressive is considered to reflect the duration of heating and cooling of each hornfels experienced, depending on the distance from the contact of the igneous body.

Pelitic hornfelses in the contact aureole of the Bushveld Complex are well exposed in the eastern Transvaal, South Africa (e.g., Kaneko & Miyano, 1990). The hornfelses, metamorphosed argillites and volcanics of the Pretoria Group, occur as floor rocks of the Complex and preserve sedimentary structure relatively well. Their bedding planes are nearly parallel with cumulate layers in the intrusive dipping gently toward the center of the Complex. The hornfelses show several textural features; (1) ghost structure in andalusite and staurolite, (2) pseudomorph consisting of quartz, biotite, muscovite, and Fe-Ti-oxide, (3) pseudomorph consisting of muscovite, biotite, quartz, Fe-Ti-oxide, and/or pinite, and (4) sillimanite enclosed with andalusite. These textures may be explained with thermal conduction history in each hornfels. Stratified and uniform-dipping structure of the sediments and the cumulate structure appear to be applicable for one-dimensional model of sheet-like magma intrusion and heat conduction from the intrusive center toward the surrounding rocks.

The ghost structure in texture (1) is parallelogrammatic or rectangular in form. The structure in andalusite includes film-like biotite, lathlike muscovite, and/or chlorite. That in staurolite contains quartz inclusions. Staurolite in contact with biotite has a portion with less inclusions, it suggests that biotite is replaced by staurolite. The pseudomorph in texture (2) shows also parallelogrammatic or rectangular shape. Inclusions of relic biotite in the pseudomorph show synchronous pleochroism and their principal vibration axes Y are parallel to the elongated direction of the pseudomorph. Textures (1) and (2) are usually present in the same hornfels and represent mutual relationship with biotite. From the relationship, precursors of both the ghost structure and the pseudomorph are most probably biotite. The ghost structure and pseudomorph were formed simultaneously with andalusite and staurolite. The pseudomorph in texture (3) represents hexagonal forms. The pseudomorphs frequently possess cordierite core, although pinitic chlorite substitutes for cordierite core in some places. Texture (3) is accounted for muscovite and biotite pseudomorph after cordierite. In texture (4), sillimanite is lathlike shape and idioblastic to subidioblastic. On the other hand, andalusite is subidioblastic to xenoblastic and often encloses the sillimanite. Texture (4) illustrates that andalusite growth is most likely to occur after sillimanite formation.

Generally pseudomorphs are interpreted for evidence of retrogressive metamorphism. However pseudomorph formed together with andalusite and staurolite in texture (2) appears to be a progressive product, while that in texture (3) shows retrogressive alteration by pinitization. Texture (4) is an evidence of retrogressive metamorphic path crossing the sillimanite-andalusite boundary.

Whether the texture is retrogressive and/or progressive is considered to reflect the duration of heating and cooling of each hornfels experienced. When one dimensional thermal conduction model was adopted, the thermal history depends on the distance from the contact of the igneous body. Hornfels at the contact is likely to show the thermal history with almost peak temperature accomplished immediately after the intrusion. The hornfels may record retrogressive reaction as shown in texture (4). At intermediate region of the contact aureole, hornfels would record the history of both heating and cooling events resulting in progressive and retrogressive reactions as shown in texture (3). Far from the contact, the hornfels could be warmed up slowly and kept at around the peak temperature for a relatively long time. At the margin of the aureole, the peak temperature may not be sufficient to cause the subsequent retrogressive reaction, so that progressive textures (1) and (2) may have been preserved.