Role of fluid in high-grade pelitic hornfels in the contact metamorphic aureole of the Bushveld Complex in the northeastern Transvaal, South Africa

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Mafic layered sequence of the Bushveld Complex intruded strata of the Transvaal Supergroup at 2.0-2.1 Ga, being accompanied by extensively-developed contact metamorphic aureole in the northeastern Transvaal, South Africa. Orthopyroxene(opx)-bering pelitic hornfels with melting texture (leucosome) is observed in places less than 1 km distant from the Bushveld Complex contact. Unmelted parts of the hornfels consist of poikiloblastic opx, biotite (lath and poikiloblast), quartz, and locally cordierite and/or plagioclase. Poikiloblastic biotite is probably of retrograde product, because it contains minute inclusions of anhedral opx. Leucosome occurs as veinlets or pockets consisting mainly of biotite, K-feldspar (perthite), plagioclase, quartz, and rarely opx and/or cordierite. K-feldspar contains in places tiny inclusions of euhedral opx and biotite. Two-pyroxene geothermometer applied to meta-diabase associated with the pelitic hornfels yielded the highest temperature of 740-790℃ at 1.8±0.5 kbar. The result is consistent with the previous estimate by means of the thermal gradients in the aureole. Revised opx-biotite geothermometer available for pelitic rocks, however, gave temperatures of 600-780℃ for the hornfels with leucosome. The leucosome is most likely to have formed at the highest temperature, but some opx and biotite appear to be reequilibrated during the retrograde metamorphism. This can be explained by equilibrium calculation of reaction; enstatite + K-feldspar + water = biotite + quartz, which could be in equilibrium at temperatures as low as 600℃ where the water activity is estimated at 0.1-0.2. It implies that fluid emanated by heating from the underlying sediments becomes high saline (no CO_2 detected) during the cooling.