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Micropores and mass transfer in the formation of myrmekites

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Abstract

The formation process of myrmekites in granitic rocks can help us to understand the mass transfer between minerals and hydrothermal fluids during the deuteric stage. The Toki granite, central Japan, has three types of myrmekites. Type A myrmekite is defined as a single layer. Type B myrmekite shows a composite texture consisting of two layers, namely, a myrmekite layer and an albite (Ab)-rich layer that is free of vermicular quartz. Type C has a composite texture with the following three layers: two myrmekite layers separated by one Ab-rich layer. Micropores are found in these myrmekites in the undeformed granite, which enable quantitative determinations of the volume decrease during myrmekite formation by measurement of the area of micropores. The areal relationship between the micropores and vermicular quartz in the myrmekites exhibited a high correlation ($R^2 = 0.8352$), thus indicating that the genesis of the micropores is evidently related to myrmekite formation. We derived the reaction equations for myrmekite formation based on the singular value decomposition method. The matrices for singular value decomposition involve the following volume factors: volume change during the reaction and volume ratios of the product minerals. The singular value decomposition indicates that the myrmekites are produced through the consumption of plagioclase and K-feldspar with an inflow of H_4SiO_4, Na^+, and H^+ from the hydrothermal fluid, accompanied by an outflow of Al^{3+}, Ca^{2+}, and K^+ into the fluid, which constitute essential mass transfers during myrmekite formation. The difference of pH in the hydrothermal fluid and inflow amounts of H_4SiO_4 and Na^+ can explain the reason why micropores occur in the myrmekites but not in the Ab-rich rim (layer); the smaller inflow of H_4SiO_4 and Na^+ from the hydrothermal fluid with lower pH conditions yielded micropore production during myrmekitization, and the larger inflow of H_4SiO_4 and Na^+ from the hydrothermal fluid with higher pH conditions yielded the formation of the Ab-rich rim (layer) with few micropores. The sequential variations in the chemical characteristics of the hydrothermal fluid during the sub-solidus conditions were characterized by a gradual decrease in H_4SiO_4 (Si^{4+}), Fe^{2+}, Mn^{2+}, Mg^{2+}, and Na^+ and a gradual increase in Ca^{2+}, K^+, H^+, and F^-.

Keywords: Myrmekite, micropore, mass transfer, image analysis, Toki granitic pluton