Zebra Rock の記載とパターン形成モデル
Description of Zebra Rock and the pattern formation model

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Zebra Rock is a sedimentary rock characterized by a pattern consisting of red and whitein color, which is characteristically seen in Australia. Loughnan and Roberts (1990) conclude that the origin of the pattern is due to the diffusion process in a sediment on the basis of their study of the mineral assemblage.However, the mechanism of the specific reaction is not explained, lacking the detailed description. Our aim is to describe Zebra Rock in more detail and to develop a pattern formation model including the reaction of mineral formation.

Six samples taken from the vicinity of Lake Argyle in the East Kimberley region of Western Australia are used. We refer to the characteristic banding pattern consisting of red bands and white bands as Red and White, respectively.

We examined the mineral compositions with XRD (Mac science CuKα radiation) and SEM-EDS (FE-SEM 15 kev, OXFORD Aztec) and the occurrence of minerals with SEM (FE-SEM 15 kev) and TEM (JEM-3200FSk) for each White and Red. By using BSD images, we examined the fraction of minerals, and the characteristics of the spatial correlations between minerals and void for White and Red. As a result, we found that there are two distinctive differences in the mineral abundance and occurrence of iron oxide between White and Red. Red contains more iron oxide than White as shown by previous study. In the occurrence of iron oxide is different. The iron oxide in White takes a shape of planer sheet of polycrystal (<100 μm) which consists of hematite grains (~100 nm), whereas the iron oxides in Red are aligned in interstitial spaces between kaolinite and quartz crystals, as aggregates (<100 μm) which consists of granular hematite grains (~ μm). In addition, from the spatial distribution analysis it is found that the iron oxides concentrate near voids both in White and Red.

Integrating these results,on the basis of the idea that the formation of iron oxide plays an essential role in the formation of zebra pattern,we develop a pattern formation model using a reaction diffusion system. In our model, the pattern is defined as the variation of concentration of ferric irons. We assume the formation process ofhematite in an aqueous solution is simplified as "ferrous ion →goethite (monomers) →goethite (precipitates) →hematite". We propose an autocatalytic reaction in which ferrous ion are adsorbed in goethite, and thereby the reaction is accelerated. As a result of the linear stability analysis for this simplest model, it is found that the equilibrium point is stable and no pattern forms. Thus, we will develop more complex reaction models to produce the zebra pattern.

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