Relationships between weathering styles and rock facies or joint structures in the Yagyu Granite, central Japan

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Weathering of granitic rocks commonly occurs deeply and shows characteristic styles. Some granitic rocks weather to form large spheroidal boulders and others form micro-sheeting instead of spheroidal boulders. Typical spheroidal weathering can be seen in the Kumano Granite Porphyry in the southeastern part of the Kii Peninsula, while micro-sheeting is well-known in the Hiroshima Granite. Both weathering styles of granite have been reported in many cases but it is still unknown why distinct weathering styles develop even in a same granite body. The Cretaceous Yagyu Granite Pluton (YGP) in the central Kinki region, Japan is overlain by the Pliocene Kitamata Gravel Beds (KGB) of the Kobiwako Group with subhorizontal unconformity and forms low-relief surfaces. Weathering of granite in this area shows spheroidal weathering in some areas and micro-sheeting in other areas. We investigated distributions of rock facies, weathering styles and joint structures in the northwestern part of YGP. Weathering styles of granite vary with the distance from the boundary between YGP and the intruded sedimentary rocks. Spheroidal weathering of granite was found from the boundary to 4 km away from it, whereas micro-sheeting or saprolite with randomly oriented cracks was found in the central part of YGP from there. Rock facies of the granite gradually change from the margin to the interior in the following order: medium-coarse biotite granite-granodiorite, coarse hornblende biotite granodiorite-tonalite, and coarse biotite granite. Rock facies around the boundary of the granodiorite and granite near the central part of YGP exhibit porphyritic textures and zonal alignment of biotite, potassium feldspar, and quartz. The structure of all the rock facies suggests that crystallization differentiation of granitic magma occurred and probably was caused by the cooling from its surroundings. Spheroidal weathering develops from the granite to the tonalite and its occurrence was not related to the presence or absence of porphyritic textures and zonal alignment of minerals. Hence, the spheroidal weathering is not controlled by rock facies. Instead, its distribution is related to joint patterns. In the margin of YGP, the major high-angle joints propagated radially from a point, and shorter high-angle joints have T-junction with the major joints. This joint pattern suggests that they are columnar joints that formed during cooling. In contrast, high-angle joints in the center of YGP had no radial pattern and are dominated by cross-cutting N-S or E-W trending joints. This joint pattern suggests that they were made under the regional tectonic stress. Consequently, spheroidal weathering of granite can be attributed to the columnar joints, and micro-sheeting may be attributed to a granite body with other type of tectonic joints.

Keywords: spheroidal weathering, microsheeting, cooling joints, granite, normal laterally compositional zoning

