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Chemical weathering index suitable for Japanese granitic rocks

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The chemical weathering of rocks proceeds mainly by water-rock interactions (Nesbitt, 1979; White and Brantley, 1995). During such weathering, several alkaline and alkali-earth elements are easily leached from rocks, whereas residual elements are redistributed into secondary minerals (Reiche, 1943; Vogel, 1975; Nesbitt et al, 1980; Nesbitt and Young, 1982; Harnois, 1988). This geochemical process has been used as the foundation for indices assessing the extent of chemical weathering of rocks, based on the whole rock chemistry. Many chemical weathering indices have been suggested in the latter part of the 20th century, with 30 or more proposed in the literature (Duzgoren-Aydin et al., 2002).

Granitic rocks are important subjects for the study of rock weathering because they are a major component of the continental surface. Numerous indices have been proposed to estimate their degree of chemical weathering (Ruxton, 1968; Vogel, 1975; Harnois, 1988). They are wide concerns in such fields of geology, environmental science, and civil engineering (Hencher and McNicholl, 1995; Irfan 1996; Nesbitt and Markovics, 1997; Panahi et al., 2000). However, many previous studies are aimed at a narrow space such as a vertical section of outcrop or a drilling core (Nesbitt and Markovics, 1997; Guan, et al., 2001; Kirschbaum, et al., 2005). A problem can arise when such indices are applied to granitic rocks sampled over wider areas at batholithic scale, because such rocks may exhibit considerable chemical variation arising from their individual petrogeneses. The underlying magmatic variation obscures patterns in chemical evolution that result from subsequent weathering (Kamei et al., 2012).

The chemical composition of weathered granitoids produced by chemical evolution during rock weathering overlaps with their original magmatic chemical variation. A useful weathering index should be applicable to a wide range of rocks, and should yield different values for each fresh parent rock and the weathered material (Fedo et al., 1995; Price and Velbel, 2003). Kamei et al. (2012) proposed a practical method for evaluation of the degree of weathering of varied granitoids over wide areas. This improved method eliminates the chemical overlap of petrogenetic effect from the chemical weathering, and can raise many classical weathering indices to practical methods.

In this study, various weathering indices are used to determine the best chemical weathering index for Japanese granitic rocks based on the improved method of Kamei et al. (2012). The result suggests that the indices constructed by mobile CaO and Na2O with immobile Al2O3 fulfill highly function. These elements are essential for plagioclase in the granitic rocks. Many researchers are discussing that the important indicative mineral for Japanese granitoid weathering is plagioclase and biotite (Miura, 1973; Kitagawa, 1999; Fukushi et al., 2000; Utada, 2003; Yokoyama and Matsukura, 2006; Kamei et al., 2012). Generally, modal composition of plagioclase in Japanese granitoids is higher than that of biotite. Therefore, it is not inconsistent with that the weathering indices based on CaO, Na2O, and Al2O3 have highly effect for the Japanese granitic rocks. The best chemical weathering index for Japanese granitic rocks would be an index that constructed by CaO, Na2O, and Al2O3.

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