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The use of cation packing index for characterizing the weathering degree of granitic rocks

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Abstract

The weathering state and weatherability of rocks are highly important for engineering geology projects and the use of rocks as building stones. The weathering state of rocks can be described by various chemical and petrographical weathering indices. To determine weathering state of a rock, considerable amount of chemical analyses is required. Weatherability of rocks depends on not only their mineral composition but also the number of cation replaceable with hydrogen in a mineral. In this study, the use of the *k*-value (cation packing index is defined as the number of cation in a mole) for characterizing the degree of weathering of granitic rocks is investigated. For the purpose of the study, the Kurtun granitic rocks are selected as the material of the study. The study contains three main stages and these are field investigations, laboratory studies and regression analyses. During the field studies, in-situ weathering descriptions and sampling are carried out. The samples are subjected to chemical and petrographic analyses and physical and mechanical tests. At the final stage of the study, a series of regression analyses between the cation packing index and other properties of the samples are performed. The results show that the *k*-value can be used as a weathering indicator. When compared with the other chemical weathering indices, the *k*-value can be used as a weathering index without chemical analyses, because it can be determined by mineralogical analyses.

Keywords: Weathering; Granite; Kurtun (Turkey); Cation packing index; Regression analyses; Rock strength

1. Introduction

The mechanical behaviour of rocks depends not only on stress state and stress history of the geologic enviroment but also on the pyhsical and chemical properties of the weathered materials. It is thus important for geotechnical studies to estimate quantitatively the changes of these properties during weathering (Guan et al., 2001). In nature, the engineering geological properties of the weathered rocks are controlled by their chemical, mineralogical and textural composition. Different compositions may bring about different degree of weathering under similar conditions and show different properties (Lan et al., 2003). On the other hand, different mechanical and index tests have been used primarily to estimate the material design parameter rapidly and economically, and to characterize the degree of weathering (Irfan, 1996). Good correlations have been found between the test indices and the engineering properties of the weathered granites (Hamrol, 1961; Onodera et al., 1974; Irfan and Dearman, 1978a). Unit weight, porosity, sonic wave velocity are the simple indices that can be used to assess the degree of weathering (Irfan and Dearman, 1978a; Irfan, 1996; Gupta and Rao, 2001; Arel and Tugrul, 2001; Begonha and Sequeira Braga, 2002; Sousa et al., 2005). Standart petrographic modal analysis has been used quantitatively to evaluate the successive mineralogical and textural changes brought about by weathering. Quantitative petrographic indices derived from this method can be directly correlated with physical and mechanical properties of the weathered granites (Irfan and Dearman, 1978a).

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There are several weathering indices proposed by various authors for characterizing weathering degree of granitic rocks. The most commonly used indices have been derived from chemical and mineralogical–petrographical analyses. Although both chemical and mineralogical–petrographical indices such as weathering potential index (WPI) (Reiche, 1943), Parker index (PrI) (Parker, 1970), Miura index (Wm) (Miura, 1973) and micropetrographic index (Ip) (Irfan and Dearman, 1978a) are used in various studies, the cation packing index (*k*-value) have not been used to characterize the weathered rocks. For this reason, in this study, the use of *k*-value to characterize the weathering grade of granitic rock and to investigate the relationships between the *k*-value and the weathering indices proposed previously and the physical and mechanical properties of a granitic rock are aimed.

According to Ollier (1983), the weatherability of a rock depends on the number of cation replaceable with hydrogen in a mineral. The *k*-value is defined as the number of cation in a mole. When considering this definition, it is possible to say that the *k*-value can be used to characterize the weathering state and weatherability of a rock. In addition;

(a) By using the *k*-value, the amount of the altered minerals by chemical leaching can be estimated,
(b) The amount of weathering products can be found by the *k*-value,
(c) The petro-physical properties of a rock can be expressed depending on weathering degree by *k*-value,
(d) Although the chemical weathering indices are calculated by results of the chemical analyses, the *k*-value is obtained from modal analyses.

For the purpose of the study, the Kurtun granodiorite is selected. The weathering grades are described in-situ and, samples for mechanical test, petrographical studies and chemical anaylsis are collected. The results obtained from these studies are assessed and discussed.

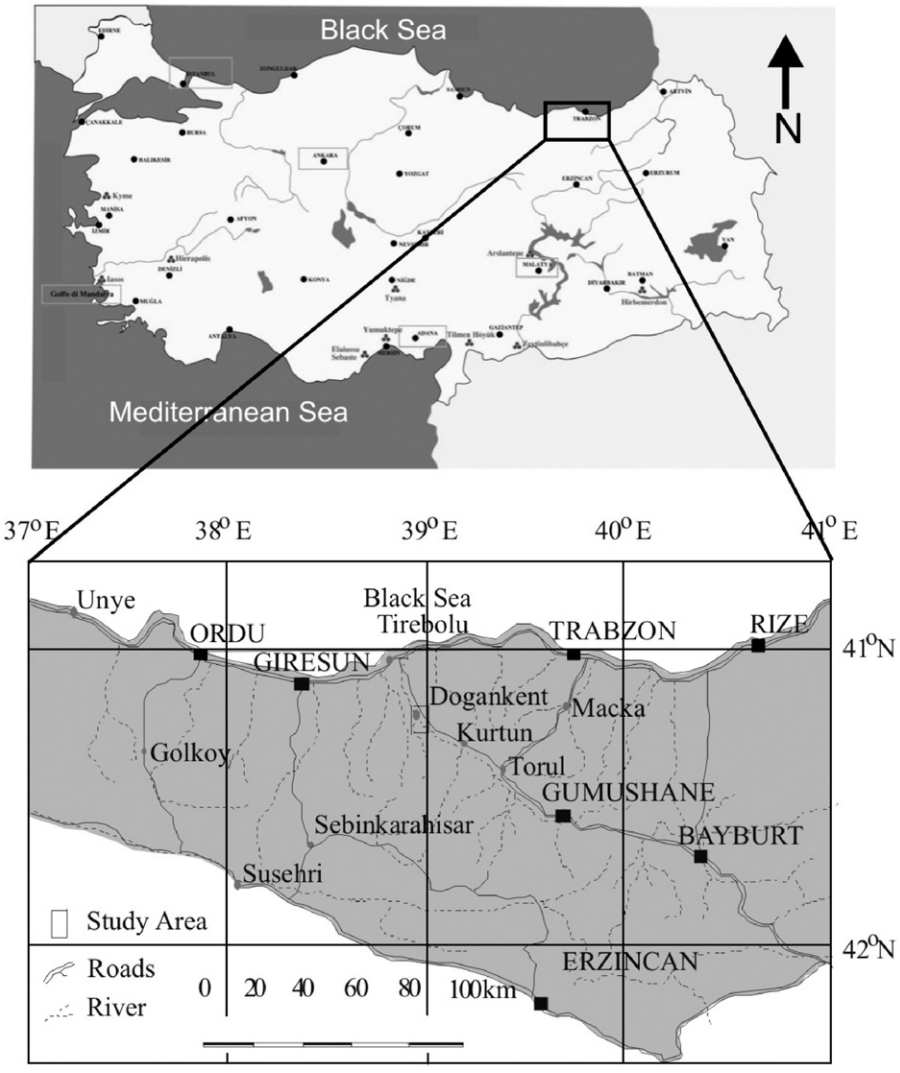

Fig. 1. Location map of the study area.