Chapter 4

Weathering Indices Used in Evaluation of the Weathering State of Rock Material

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ABSTRACT

There are various definitions of weathering and differences between authors seem to stem in part from the different viewpoints of pedologists, geomorphologists, geologists, geochemists, and geology engineers. In this study, weathering is handled from various aspects such as time, form, and phases of progress, studies it is majored in research scale. The engineering behavior of rock materials depends not only on stress state and stress history but also on the physical, mineralogical, and chemical change of the rock materials due to weathering. Weathering indices are used to define these changes due to weathering. Several weathering indices have been devised for quantifying the changes in the intrinsic properties of rocks from different points of view, some of which can be related to the engineering properties of weathered rocks. The most commonly used methods can be broadly categorized as chemical, mineralogical-petrographical, petro-chemical, and engineering indices. In this study, the brief literature review for weathering indices used to evaluate the effects for weathering of rock materials.

1. INTRODUCTION

The term ‘weathering’ has been in use for a very long time but it has come to mean different things to different people and hence, as scientific short-hand, it no longer functions (Hall et al. 2012). Weathering studies cover a quite large variety of topics, often accomplished by applying multi- or trans-disciplinary approaches, in turn involving multi-scale and multi-analytical procedures (Scarciglia et al. 2016).

It is known that the weathering processes result the change of the physical, mineralogical, chemical, and mechanical properties of the rock materials. The changes in these properties of a rock during the weathering process allow calibrating the degree of weathering. Based on those properties, various weathering indices can be used as tools for this purpose (Udagedar et al. 2016). The most commonly

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used methods in setting weathering definition can be broadly categorized as chemical, mineralogical-petrographical, petro-chemical and engineering indices.

Decomposition of rocks is one of the fundamental processes that modify the earth’s surface (Lee et al. 2008). Decomposition due to weathering and hydrothermal alteration is calculated in different ways, including using the normalized values of elements (or oxides) by using their parent rock concentrations or the immobile element concentrations in the samples (Krauskopf 1967), employing standard cell calculation (Colman 1982), calculating the ratio of elements to immobile elements (Chesworth et al. 1981, Colman 1982, Guan et al. 2001), the gamma-ray spectrometric study (Chen and Chan 2002), determining cation exchange capacity (Arikan et al. 2007), using an EC/pH meter (Shalkowski et al. 2009) and reflectance spectroscopy (Hyun and Park 2011). Alternative methods of calculating the change in weight or volume of rock materials due to chemical weathering include using immobile elements (Huston 1993), modelling compositional changes (Eynatten et al. 2003), using the k-value (Ceryan et al. 2008b, Ceryan 2011, Ceryan 2015) and applying chemical weathering indices (Price and Velbel 2003, Ceryan 2008, Ceryan et al. 2008a-b, Ceryan 2012, Gong et al 2013, Ceryan 2015).

The engineering behavior of rock materials depends not only on stress state and stress history but also on the physical, mineralogical and chemical change of the rock materials due to weathering. Weathering causes rock material to become more porous, individual mineral grains to be weakened and bonding between grains to be lost (Ceryan et al 2008a-b). Generally spoken, rock will lose strength and become more deformable and its permeability may change depending upon the nature of the rock, the presence and type of weathering products and the stage of weathering (Ceryan et al 2008a-b). The engineering weathering indices are based on these changes in the physical and mechanical properties of rock materials.

In this study, the weathering concept was discussed from the different viewpoints and especially focused on chemical weathering indices and their usage. In addition, engineering weathering indices was given in detail.

2. BACKGROUND

Alteration and weathering concepts are mostly used at the same meaning and in general these concepts express physical and chemical differences existing later in mineral and rocks (Gary et al. 1972). There are various definition of weathering and differences between autors seems to steam in part from the different viewpoints of pedolog, geomorpholog, geolog, geochemists and geology engineer. Weathering is a fundamental process in the geological cycle that should be regarded as of equal importance as the processes of metamorphism, volcanism, diagenesis, erosion, etc., that are much more extensively studied in most departments of earth science (Wilson 2004). Indeed, a case could be made for mineral weathering to be considered as the most important process in the geological cycle as it most directly affects the living world in general and the life of man in particular (Wilson 2004). Thus, weathering is responsible for the formation of soils, upon which nearly all terrestrial life ultimately depends, playing a central role in controlling the inherent fertility status of soils through the supply of many of the nutrients that enable plants to grow. Again, in more recent times it has been realized that mineral weathering acts as a buffer against a variety of environmental threats that are of direct concern to man (from Wilson 2004).

Weathering can be handled from various aspects such as time, form and phases of progress, studies it is majored and research scale (Ceryan 2012), (Figure 1). Weathering of naturally occurring is divided two types with respect to the time scale; weathering in geological time and weathering in engineering