The effect of acid rain on weathering characteristics of riprap rocks

Kumamoto Univ.Student Member ○ Jafar Ghayoumian
Kumamoto Univ.Student Member Yoshifumi Ito
Kyushyu Electric Power Co. Yoshitake Eto
Kumamoto Univ.Member Shigeki Nakajima

INTRODUCTION

Acid rain is largely considered as one of the most serious environmental problems[1]. In this research the effect of acid rain on weathering characteristics of riprap rocks is investigated.For this purpose different rocks which have been used as riprap rocks in three dam sites were exposed to dissolution test, and concerning the rate constant K the rocks were classified .Finally for evaluation of the probable changes in the rocks compositions X-ray diffraction analysis (X.R.D) was performed for the both cases,fresh samples and the samples which were exposed to weathering processes.

Samples and experimental procedure

The samples were taken from three dam sites in Kyushu. The rocks type and their chemical composition are given in table-1, in which A, C, E show weathering rate for the same rock.The samples were grounded using a mechanical grinder up to the size 0.42 ~0.25 mm.Distilled water was used as solvent in the dissolution test, for evaluation the weathering characteristics of riprap rocks the Ph of the solvent was decreased to about 4.0 to be comparable to the Ph of acid rain which is agreed to be about 4.0 in severe condition. Some picnometers containing 20 gr of specimens and 250 cc of the solvent were placed inside a shaker and the shaking rate was adjusted to be 100 times per minute.

Table-1 Chemical composition of rocks

	SiO_2	Al_2O_3	Fe_2O_3	CaO	K_2O	MgO	Na_2O	MnO	TiO_2	BaO	Total
Slate A	63.85	17.46	8.88	3.53	3.76	0.42	1.03	0.15	0.68	0.34	100.00
Slate C	59.17	17.57	8.87	8.00	3.69	0.49	1.24	0.14	0.84	0.0	100.01
Slate E	66.23	17.18	9.67	0.81	3.77	0.38	0.88	0.11	0.72	0.29	100.02
Green R A	58.32	15.47	10.44	10.97	1.86	0.66	1.33	0.18	0.71	0.09	100.00
Green R C	58.28	19.09	15.02	1.53	2.92	0.16	0.89	0.27	1.51	0.33	100.00
Green R E	67.58	16.23	8.5	1.49	3.73	0.35	0.70	0.07	0.90	0.49	100.04
Black Sch	64.91	16.37	9.06	3.08	4.26	0.32	0.72	0.15	1.12	0.0	99.99
Green Sch	62.71	14.46	12.23	7.31	0.33	0.52	1.08	0.12	1.26	0.0	100.02
Sand Stone	73.50	14.33	5.78	2.87	2.03	0.12	0.66	0.11	0.59	0.0	99.99
Aplite	80.74	12.42	0.96	0.82	3.34	0.10	0.42	0.20	0.0	0.06	100.00

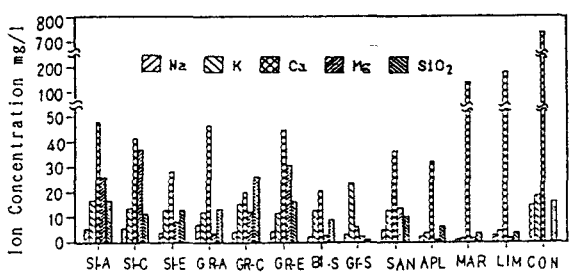

Fig-1 Comparison of dissolved components for different rocks

The concentration of main ions including Ca^{2+},Mg^{2+},Na^{+},K^{+} and SiO_2 were measured with elapse of time as shown in Fig.1. For comparison purposes two extra rocks such as limestone and marble(which are more sensitive to chemical weathering) and a kind of concrete were tested.Fig.2 shows the total ion concentration vs time for all of the tested rocks.As the behaviour is similar to the dissolution of minerals , the parabolic rate law was used for measurment of the rate constant K, as follows:

$$Q_i = K_i t^{1/2} + Q_{i0}$$

Q, represent the amount of element in the solution at time t,K, is a rate constant. Table.2 illustrate the rate constant for tested rocks.Finally the samples in both cases fresh samples and the samples which were exposed to the dissolution for 40 days were subjected to X.R.D analysis to determine the probable alteration of the minerals.

Disscution and result

The experiments show that there is no direct relation between rock composition and the amount of dissolved ions.Conserning the values of rate constant all of the tested rocks except one case have the same order,which means there is no significant changes in the dissolution of the tested rocks.

Fresh rocks compared to weatherd ones are more sensitive to dissolution processes,and in general by increasing rate of weathering the rate constant K decreases for the same kind of rock.

The tested rocks can bo divided into four groups which are:group 1 (Green Schist, Black Schist,Aplite) ,group 2 (Sandstone, Green Rock-E, Slate-E) Group 3 (Slate-A,C ,Green Rock-A,C) and group 4 (Concrete, Limestone and marble) .

X.R.D analysis shows that while for some rocks which showed very small rate constant there is no chages, in the rocks which showed bigger rate constant a slight mineral alteration can be observed. More research is necessary to evaluate the effect of different conditions such as presure, temperature and Ph on weathering rate.

REFRENDES

1)Eiju Yatsu ;The Nature of Weathering, Sozosha.1986 2)James I.Drever;The Geochemistry of Natural Waters,1988

3)A.Lerman et.al;Physical and Chemical Weathering in Geochemical Cycles, Nato ASI series

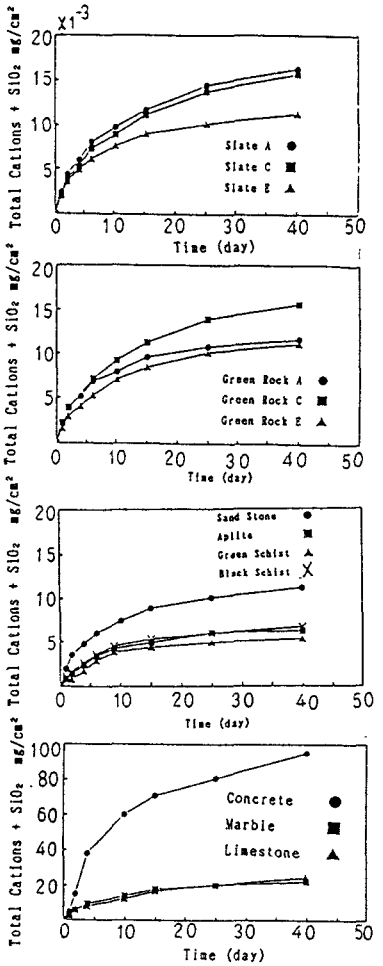

Fig-2 Total amount of dissolved components released as a function of time

Table -2 The value of rate constant for tested rocks

Kind of Rock	Specific Gravity G	Surface area cm^2/g	K ug/cm^2
Slate-A	2.770	86.64	$2.94x10^{-3}$
Slate-C	2.773	86.55	$2.52x10^{-3}$
Slate-E	2.765	86.80	$2.48x10^{-3}$
Green.R-A	2.751	87.24	$2.72x10^{-3}$
Green.R-C	2.778	86.39	$2.63x10^{-3}$
Green.R-E	2.779	86 36	$2.00x10^{-3}$
Sandstone	2.721	88.20	$2.44x10^{-3}$
Aplite	2.642	90.84	$1.04x10^{-3}$
Black Sch	2.750	87.27	$1.34x10^{-3}$
Green Sch	2.856	84.03	$6.27x10^{-4}$
Limestone	2.700	88.89	$3.99x10^{-3}$
Marble	2.713	88.46	$3.65x10^{-3}$
Concrete	2.338	102.74	$8.05x10^{-3}$