# Artificial chemical weathering of plagioclase under earth surface conditions

YUMI BABA[1], SHOICHI KOBAYASHI[1]
AND TAKABUMI SAKAMOTO[2]

[1]Graduate school of Science, Okayama University of Science, 1-1 Ridai-cho, Okayama 700-0005, Japan (s07sm07hy@std.ous.ac.jp, kobayashi@das.ous.ac.jp)
[2]Faculty of Risk and Crisis Management, Chiba Institute of Science, 3 Shiomo-cho, Choshi 288-0025, Japan (tsakamoto@cis.ac.jp)

"Acid rain" is one of the global environmental problems. In order to predict the effect of acid precipitation on building stone, artificial chemical weathering of plagioclases composed in granitic and gabbroic building stones have been simulated chemically and mineralogically. Oligoclase from Minas Gerais, Brazil and bytownite from Chihuahua, Mexico have been exposed to $HNO_3$, $H_2SO_4$ and HCl solutions at pH 4, and distilled water at 50□ for different periods of time up to 550 days in an open system using an improved Soxhlet extraction apparatus. Morphological and chemical changes of the mineral surfaces were studied by SEM, EPMA and microscopic techniques. Alteration products were collected from the each mineral surface and examined using XRD and TEM. The leached sample solutions were analyzed for major elements such as Si, Al, Fe, Ca, Mg, Mn and Na, and minor elements such as Zn, Ni, Co and so on using ICP-AES and ICP-MS. The SEM images of the artificial weathered oligoclase and bytownite surfaces showed that many irregular fractures formed by dissolution have developed on the minerals. Molar ratios of each element in the leached solutions to those in the fresh each mineral that is starting material varied depending on the experimental period. The ratios of the elements such as Ca, K, La, Ce, Nd and Sm were relatively high. On the other hand, the ratio of Na, one of the major elements, is very low. Ca/Al and (Na+Ca+K)/Al ratios for oligoclase and bytownite surfaces decreased with an increase in leaching time. Smectite appeared to be formed from bytownite, but no altered product from oligoclase was detected during the artificial chemical weathering.

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# Tales and facts about rodingite and diopsidite in oceanic mantle sections

WOLFGANG BACH AND FRIEDER KLEIN

Geoscience Department, University of Bremen, Germany (wbach@uni-bremen.de, fklein@uni-bremen.de)

Gabbroic dikes in the ocean lithospheric mantle commonly undergo hydrothermal transformation to rodingites featuring a range of Ca-Al and Ca-silicates. Rodingites are often thought of as products of extreme Ca metasomatism and it is sometimes inferred that high fluxes of fluids derived from serpentinization processes are required in their formation. A similar rock type, diopsidite, has recently been interpreted as a witness of very high-T (>800°C) fluid circulation [1].

We used thermodynamic reaction path models to provide insights into the formation of metasomatized rocks at mafic/ultramafic boundaries. The models were set up to investigate the shifts in fluid-rock equilibria as fluids move from peridotite undergoing serpentinization into a gabbroic body. Phase relations were investigated in the direction of increasing extent of reaction of the serpentinization fluid with gabbro at 200°C, 300°C, and 400°C. Phase assemblages typical of rodingite (grossular+diopside±chlorite) are predicted to form at 200°C and 300°C but only in areas where the fluid is essentially unaffected by reactions with gabbro, i.e, near the contact with ultramafic rock or adjacent to a fissure filled with serpentinization fluid. As the fluid becomes more affected by reactions with the gabbro, prehnite or epidote replace garnet and tremolite replaces clinopyroxene. Once the fluid chemistry is completely reset by reactions with gabbro, the predicted assemblage is typical of greenschist facies: albite, actinolite, chlorite, and epidote.

Our model results support the hypotheses that rodingites form during serpentinization but only in areas where the fluid composition is controlled by serpentinization reactions. Specific results of our modeling study are: (1) The formation of mineral assemblages and spatial mineralogical variability within rodingites from the ocean floor is mainly driven by steep gradients in aqueous silica activity of stagnant pore fluids. (2) Rodingite formation does not require large fluxes of fluids rich in Ca, and it must not be viewed as infiltration Ca-metasomatism. Instead rodingitization is more likely caused by diffusive loss of silica. (3) Our models predict the formation of diopsidite from gabbroic and clinopyroxenite precursor rocks at temperatures around 250°C, indicating that very high temperatures on the order of 800°C are not required. Conversely, the phase relations show that T>400-450°C can be excluded if garnet is associated with diopside.

[1] Python *et al.* (2007) *EPSL* **255**, 289-305.