Chemical Reactivity of Mica, K-Feldspar and Apatite in Organic Acids and Water

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Introduction

Mineralogical characteristic of minerals and biogeochemical processes in nature are the key factors controlling the chemical weathering process that leads to the release of ions from the mineral which provide the essential elements for higher plants, with the exception of nitrogen. Therefore, study of the short term stability of mica, feldspar and apatite in different geochemical conditions leads (1) to identify the least stable mineral under natural conditions, (2) to estimate the possible potential for use as fertilizer and (3) to understand the stability of mineral mixtures.

Materials and methods

Different proportions of powdered minerals (< 125 μm) were mixed with (1) organic matter with water, (2) water and (3) 2% citric acid. The mixtures were kept under ambient conditions while controlling the moisture content. The water soluble ionic concentrations of each mixture were measured and their variations with the time were studied.

Results

According to Figures 1 and 2 both mica and feldspar release higher values of potassium compared to other ions when they are in water or in moist organic matter.

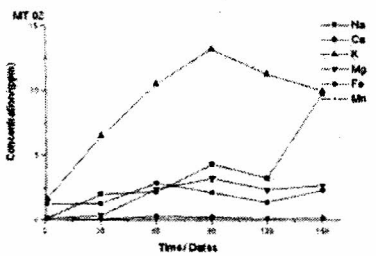

Figure 1(a) Feldspar

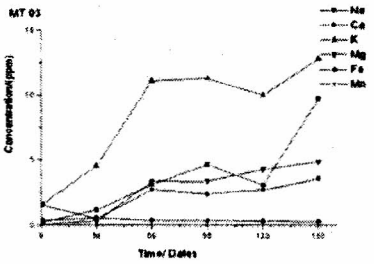

Figure 1(b) Biotite

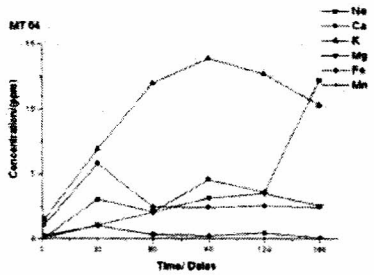

Figure 1(c) Organic matter and apatite (5:1 w/w)

Figure 1. Variations of concentrations of available ions of treated minerals with organic matter

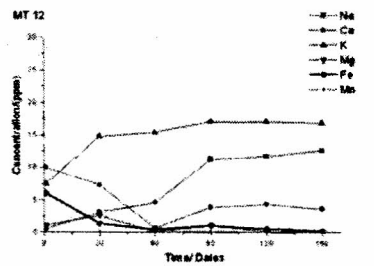

Figure 2(a) Feldspar

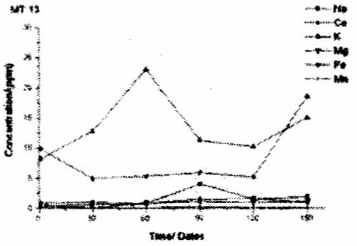

Figure 2(b) Biotite

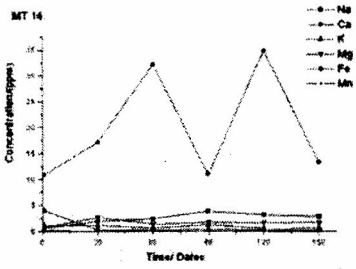

Figure 2(c) Apatite

Figure 2. Variations of concentrations of available ions of treated minerals with water

The trend shows that the calcium, magnesium, sodium gradually increase from all the mineral – organic matter mixtures although potassium released is decreased except from the mixture containing mica. Magnesium, iron and manganese contents in water is constant throughout the period in all the mixtures while the potassium and the sodium content appear to be reaching to a constant value. Mixture of water and biotite is characterized by the highest iron concentration compared to others. Calcium content in water shows irregular variation in the systems containing apatite.

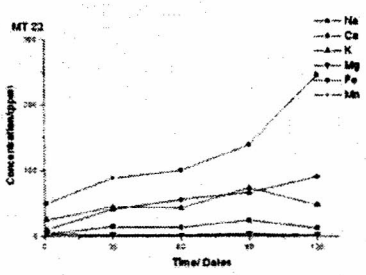

Figure 3(a) Feldspar

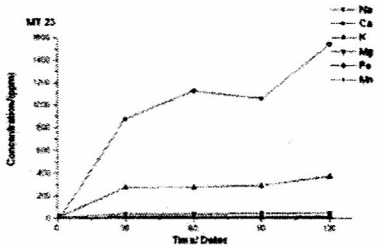

Figure 3(b) Biotite

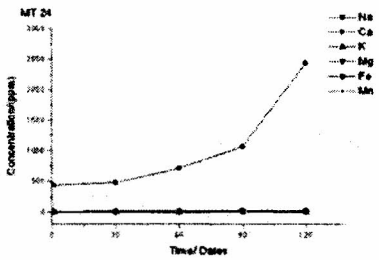

Figure 3(c) Apatite

Figure 3. Variations of concentrations of available ions of treated minerals with 2% citric acid

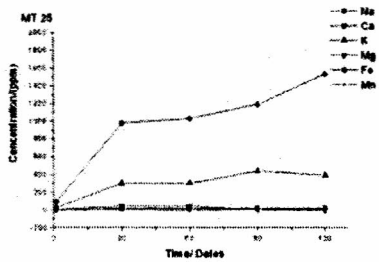

Figure 4(a) Feldspar (10 g) + biotite (10 g)

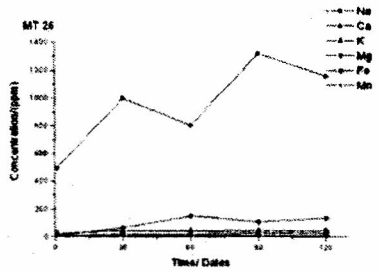

Figure 4(b) Feldspar (10 g) + apatite (10 g)

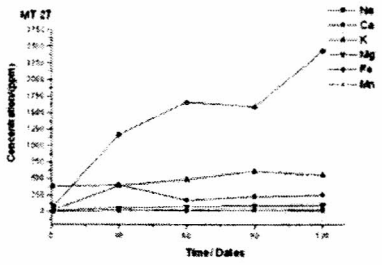

Figure 4(c) Apatite (10 g) + biotite (10 g)

Figure 4. Variations of concentrations of available ions of treated mineral mixtures with 2% citric acid

Release of ions from the mineral and the mixture of minerals in the acidic media (pH = 2-3) is illustrated in Figure 3 and 4. Mica releases considerably higher amounts of iron while the apatite releases higher amount of calcium. Rapid increases of calcium from the apatite and the iron from biotite were noted. The results clearly indicated that the amount of calcium releases from apatite and feldspars are affected by the presence of biotite under the acidic conditions.

Discussion

Systems with biotite release more ions into the systems as the interlayer ions were easily leached from the mica structure. Apatite containing phosphate anionic complex is less stable than the tectosilicates feldspars and hence feldspars are more stable in both natural solutions and citric acid medium.

Under the higher acidic conditions, all minerals release more ions than natural conditions since process of chemical weathering is more rapid than the number of biogeochemical reactions in natural systems. Release of higher concentrations of iron from the biotite in acidic medium inhibits the release of Ca from the apatite and the feldspars due to formation of complexes.

Conclusions

Dissolution of minerals is controlled by their mineralogical characteristics and the chemical nature of solutions. Mica and apatite can be used as multi-nutrient fertilizers for long term crops growing on acidic soils.

Acknowledgements

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References

Weerasuriya, T.J., Pushpakumara, S. and Cooray, P. I. (1992) Acidulated pegmatitic mica:A promising new multi-nutrient mineral fertilizer, *Nutrient Cycling in Agroecosystems*, 34(1), 6.