THE LEACHED LAYER FORMED ON WOLLASTONITE IN AN ACID ENVIRONMENT

by

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Thesis submitted to the Faculty of the

Virginia Polytechnic Institute and State University

in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

in

Geological Sciences

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April, 1997
Blacksburg, Virginia

ABSTRACT

Experiments were carried out in a fixed-bed external recycle mixed flow reactor to measure the rate of dissolution and the development of a leached layer on wollastonite. Each experiment ran for approximately 24 hours and the release rates of Si and Ca in the interval from 14 to 24 hours were analyzed. Each experiment began with an incongruent stage where Ca was released faster than the silica that remained on the surface to form the leached layer.

The silica release rate after 14 hours was 2.13×10^{-9} ($\pm 1.03 \times 10^{-9}$, 1σ, n=67) $mol/m^2/sec$, and this rate appeared to be independent of pH from pH 2 to 6 at 25°C. BET surface area measurements of reacted wollastonite showed large increases in A_{sp} over the course of experiments even though both the Ca and Si release rates decreased. These large increases of measured A_{sp} were the result of the growing internal porosity of the leached layer, and much of this surface does not seem to contribute to Si release rates.

From these data, we infer that the overall reaction for the hydrolysis of wollastonite in an acid environment is best explained by two relatively independent reactions. First, Ca is removed from the crystal leaving behind linear silica polymers; then the silica polymers are released into solution where they hydrolyze to form H_4SiO_4.

$$nCaSiO_3 + 2nH^+ \rightarrow nCa^{2+} + (H_2SiO_3)_n$$
$$(H_2SiO_3)_n + nH_2O \rightarrow n(H_4SiO_4)$$

As the leached layer grows in thickness, the Ca release rate slows because it is controlled by transport through the leached layer. A model of Ca diffusion through the leached layer shows that the leached layer grows thicker at lower pH and presents a longer diffusion path for Ca transport into the solution. This diffusion limited reaction offsets the faster rate of the Ca hydrolysis reaction so that at steady state the Ca rates should also become equal to the Si release rate.

ACKNOWLEDGMENTS

Foremost I must express my gratitude to my wife, JoAnn, for providing me with both the opportunity and the support to complete this project; without her none of this would have been possible. Special thanks are due to my advisor, Dr. Don Rimstidt, for his patience, guidance, and advice; whenever I thought this project was heading somewhere he reminded me of where it should go. Appreciation also goes to Drs. James Craig and Mike Hochella for their review of this manuscript, their insights, and their help in all areas. I would be remiss if I did not acknowledge Dr. Jodi Rosso, who not only was the catalyst behind this study, but supported me with excellent feedback throughout the endeavor. Last, thanks must be extended to all those graduate students who supported me through the past months with both friendship and assistance.

TABLE OF CONTENTS

Abstract ii
Acknowledgments iv
List of Figures vi
List of Tables vii
Introduction 1
Materials and Methods 1
    Reactor Design 3
    Experimental Protocol 5
    Analytical Methods 6
Results 6
Discussion 16
Conclusion 22
References 24
Appendix A: Nomenclature 26
Appendix B: Wollastonite EDX Analysis 27
Appendix C: Reactor Engineering Drawing 28
Appendix D: Experimental Data 29
Vita 30

LIST OF FIGURES

Fig. 1a. SEM photograph of unreacted wollastonite.. 2
Fig. 1b. SEM photograph of reacted wollastonite 3
Fig. 2. Fixed bed external recycle reactor schematic.. 4
Fig. 3. System schematic 5
Fig. 4. Log rate of Ca and Si versus pH 8
Fig. 5. Si and Ca release rates versus time... 9
Fig. 6. Si release rate comparison 10
Fig. 7. Ca release rate comparison 11
Fig. 8. Evolving BET A_{sp}... 14
Fig. 9. Leached layer versus pH.. 15
Fig. 10. BET A_{sp} versus calculated leached layer... 16
Fig. 11. Si release rate for evolving A_{sp} from experiment Hr.. 18
Fig. 12. Model of wollastonite dissolution 20
Fig. 13. Model of Ca diffusion 22
Fig. 14. Wollastonite dissolution comparison.. 23

LIST OF TABLES

Table 1. Run conditions and results 7
Table 2. Si and Ca average rates 11
Table 3. Surface area and leached layer data 13