

คุณลักษณะตะกอนจากเหมืองทองคำกับการชะละลายและการเคลื่อนที่ของโลหะหนักในดินลูกรัง

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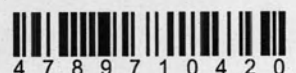
วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรดุษฎีบัณฑิต

สาขาวิชาการจัดการสิ่งแวดล้อม (สหสาขาวิชา)

บัณฑิตวิทยาลัย จุฬาลงกรณ์มหาวิทยาลัย

ปีการศึกษา 2551

ลิขสิทธิ์ของจุฬาลงกรณ์มหาวิทยาลัย



4 7 8 9 7 1 0 4 2 0

CHARACTERIZATION OF GOLD MINE TAILINGS AND HEAVY METALS LEACHING
AND TRANSPORT IN LATERITIC SOIL


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A Dissertation Submitted in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy Program in Environmental Management
(Interdisciplinary Program)
Graduate School
Chulalongkorn University
Academic Year 2008
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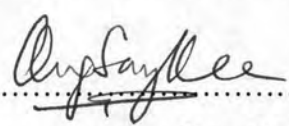
Thesis Title Characterization of Gold Mine Tailings and Heavy Metals Leaching
and Transport in Lateritic Soil
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Field of Study Environmental Management
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Fulfillment of the Requirements for the Doctoral Degree

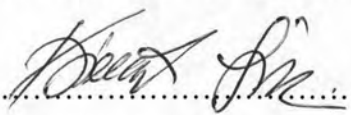
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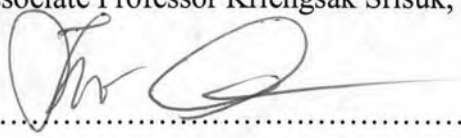
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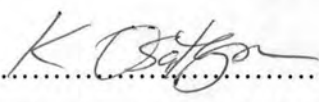
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ศรีเลิศ โชติพันธรัตน์ : คุณลักษณะตะกอนกากแร่จากเหมืองทองกับการชะละลายและการเคลื่อนที่ของโลหะหนักในดินลูกรัง (Characterization of Gold Mine Tailings and Heavy Metals Leaching and Transport in Lateritic Soil) อ. ที่ปริกษานิพนธ์หลัก: ศ.ดร. Say Kee Ong, อ.ที่ปริกษาาร่วม: ผศ.ดร. จักรพันธ์ สุทธิรัตน์, 172 หน้า

การศึกษานี้ได้ประเมินการชะละลายของโลหะหนักของตะกอนกากแร่ที่เกิดจากการทำเหมืองและศึกษาการเคลื่อนตัวของโลหะหนักในดินลูกรังภายใต้สภาวะพีเอชและความเข้มข้นที่แตกต่างกัน ค่าความเข้มข้นของโลหะในตะกอนกากแร่ไม่เกินค่ามาตรฐานดินเพื่อการอยู่อาศัยและเกษตรกรรมยกเว้นแมงกานีส อย่างไรก็ตามผลจากการชะละลายของโลหะหนักจากตะกอนกากแร่ภายใต้สภาวะพีเอช 5-6 พบตะกั่วที่ความเข้มข้นประมาณ 18 มิลลิกรัมต่อลิตรซึ่งมีค่าสูงกว่ามาตรฐานของตะกั่วในน้ำดื่ม ในการศึกษาการเคลื่อนตัวของโลหะหนักในคอลัมน์ดินลูกรังพบว่าตะกั่วมีความสามารถในการดูดซับมากที่สุดทั้งในสภาวะพีเอช 4 และ 5 ค่าความหน่วงของการเคลื่อนตัวและความสามารถในการดูดซับของโลหะหนักทั้ง 4 ชนิดได้แก่ ตะกั่ว สังกะสี นิกเกิล และแมงกานีสที่พีเอช 5 มีค่าสูงกว่าที่พีเอช 4 ค่าความหน่วงในการเคลื่อนตัวเรียงลำดับจากค่าสูงสุดไปค่าต่ำสุดดังนี้ค่าความหน่วงของการเคลื่อนที่ของตะกั่วมากกว่าสังกะสี แมงกานีส และนิกเกิลตามลำดับที่พีเอช 4 และค่าความหน่วงของการเคลื่อนตัวของตะกั่วมากกว่าสังกะสี นิกเกิล และแมงกานีส ตามลำดับที่พีเอช 5 กราฟแสดงการเคลื่อนตัวของโลหะหนักมีรูปร่างไม่สมมาตรและส่วนท้ายของกราฟที่มีลักษณะยาวซึ่งแสดงให้เห็นพฤติกรรมความไม่สมดุลในการดูดซับที่เกิดขึ้น ผลจากการประยุกต์ใช้แบบจำลอง 2-site ใน HYDRUS-1D สามารถอธิบายลักษณะดังกล่าวได้ดีกว่าแบบจำลองแบบสมดุลทั้งไอโซเทอมแบบเชิงเส้น และไอโซเทอมของแลงมัวร์ นอกจากนี้พื้นที่ในการดูดซับแบบสมดุลมีค่าอยู่ในช่วง 30-58 เปอร์เซ็นต์ สำหรับในระบบที่มีโลหะหนักอื่นๆ ได้แก่ สังกะสี นิกเกิล และ แมงกานีส อยู่ร่วมกับตะกั่ว จะส่งผลให้ค่าความสามารถในการดูดซับของตะกั่วมีแนวโน้มลดลง เมื่อความเข้มข้นของโลหะหนักชนิดอื่นมีค่าสูงขึ้น การประยุกต์ใช้แบบจำลองแบบสมดุลทั้งไอโซเทอมแบบเชิงเส้น และไอโซเทอมของแลงมัวร์ไม่สามารถอธิบายกราฟการเคลื่อนตัวของโลหะหนักในคอลัมน์ดินลูกรังทั้งด้านขาขึ้นและขาลงของกราฟในระบบที่มีโลหะหนัก 2 ชนิดและ 4 ชนิด สำหรับแบบจำลอง 2-site สามารถอธิบายกราฟการเคลื่อนตัวของโลหะหนักทั้งด้านขาขึ้นและส่วนเริ่มต้นของขาลงได้ดี แต่ไม่สามารถอธิบายในส่วนท้ายของกราฟดังกล่าวได้

สาขาวิชา การจัดการสิ่งแวดล้อม
ปีการศึกษา 2551

ลายมือชื่อนิสิต..... ศรีเลิศ โชติพันธรัตน์
ลายมือชื่ออ.ที่ปริกษานิพนธ์หลัก..... Ouy Say Kee
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4789710420 : MAJOR ENVIRONMENTAL MANAGEMENT

KEY WORDS: LATERITIC SOIL / MINE TAILINGS / HEAVY METALS / CHEMICAL NONEQUILIBRIUM / SORPTION/ TRANSPORT MODELING

SRILERT CHOTPANTARAT: CHARACTERIZATION OF GOLD MINE TAILINGS AND HEAVY METALS LEACHING AND TRANSPORT IN LATERITIC SOIL THESIS PRINCIPAL ADVISOR: PROF. SAY KEE ONG, PH.D., THESIS CO-ADVISOR: ASST. PROF. CHAKKAPHAN SUTTHIRAT, 172 pp.

This study evaluated the leaching/desorption of metals from mine tailings and investigated the movement of these heavy metals in mine lateritic soils under different pH and concentration conditions. Except for Mn²⁺, the concentrations of metals in the tailings were found to be within the concentration of the Thailand Soil Standards for Habitat and Agriculture. However, leaching of metals from the tailings at pH 5-6 showed that Pb²⁺ (18 mg L⁻¹) exceeded the drinking water standard for Pb²⁺. Using soil column studies, Pb²⁺ had the higher sorption capacity and retardation factors than those of Mn, Ni and Zn at pH 4 and 5. Retardation factors and sorption capacity of these heavy metals (i.e., Pb, Mn, Ni and Zn) at pH 5 were higher than at pH 4. The retardation factors from largest to smallest were: Pb²⁺ > Zn²⁺ > Mn²⁺ > Ni²⁺ for pH 4 and Pb²⁺ > Zn²⁺ > Ni²⁺ > Mn²⁺ for pH 5. The breakthrough curves of the heavy metals showed asymmetrical shapes with long tailing, indicating the presence of chemical nonequilibrium process. The two-site nonequilibrium model of HYDRUS-1D described the experimental data better than the local equilibrium convection-dispersion model using linear and Langmuir sorption isotherms. The fractions of instantaneous sites were found to range from 30-58 %. In the presence of other metals, competition for sorption sites were observed as seen by the lower maximum sorption capacities of Pb²⁺ for increasing concentration of the secondary metals (Zn²⁺, Ni²⁺, and Mn²⁺). Use of local equilibrium convection-dispersion model with linear and Langmuir isotherm did not describe the rising and declining limbs of metal concentration in binary and multi-metal systems. The two-site model (TSM) described the rising limb and initial declining limb well but could not explain the extended tailing phenomenon.

Field of study: Environmental Management

Academic year: 2008

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Principal Advisor's signature.....*Say Kee Ong*.....

Co-advisor's signature.....*Chakkaphan Sutthirat*.....

ACKNOWLEDGEMENTS

My great respect and heartfelt appreciation go to my advisor, Prof. Dr. Say Kee Ong. I could not have completed this research without the expertise and inspirational support he provided through his invaluable comments and fruitful suggestions. I would also like to express my sincere gratitude to my co-advisor, Asst. Prof. Dr. Chakkaphan Sutthirat for his encouragement, kindness and continuous support throughout this research. I gratefully acknowledge the suggestions and valuable comments of Asst. Prof. Dr. Khemmarath Osathaphan on the tailing phenomenon and soil column packing. Furthermore, I gratefully acknowledge the valuable discussions and comments of the Committee Chairman, Dr. Chantra Tongcumpou, and the committee members, Assoc. Prof. Dr. Kriangsak Srisuk and Assoc. Prof. Dr. Jin Anotai. I would like to extend my gratitude to Dr. Manaskorn Rachakornkij, the Program Director, who encouraged me and reviewed my progress. In addition, I wish to thank the National Center of Excellence for Environmental and Hazardous Waste Management (NCE-EHWM), Chulalongkorn University, for the wonderful experiences and financial support during my study. I especially appreciate the assistance of the staff of the Center. Also, I would like to thank the Geology Department, Faculty of Science, Chulalongkorn University for providing funding throughout my study. I would like to thank my friends who helped me while I was conducting my column studies.

Finally, my most heartfelt thanks go to my parents, brother and sister for their understanding, love and encouragement. Above all, I thank the Almighty God for granting me the strength, patience, energy and perseverance to bring my research to fruition.

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b	The maximum amount of solute that can be adsorbed by the solid [mg g^{-1}]
ρ	Bulk density of aquifer [g cm^{-3}]
C^*	Amount of solute sorbed per unit weight of solid [mg g^{-1}]
C	Concentration of solute in liquid phase [mg L^{-1}]
C_{eq}	The equilibrium concentration in solution [mg L^{-1}]
CEC	Cation Exchange Capacity [$\text{cmol}_c \text{ kg}^{-1}$]
D_L	Longitudinal dispersion coefficient [$\text{cm}^2 \text{ hr}^{-1}$]
D_m	Effective molecular diffusion coefficient for the solute of interest in soil water [$\text{cm}^2 \text{ hr}^{-1}$]
D_T	Transverse dispersion [$\text{cm}^2 \text{ hr}^{-1}$]
f	The fraction of mobile region
K_d	Linear distribution coefficient [L mg^{-1}]
K_f	The distribution coefficient [L mg^{-1}]
N	Dimensionless constant typical with a value of $N < 1$
PV	Pore volume
Q_{max}	An adsorption constant related to the binding strength of the solute on the matrix surface [L mg^{-1}]
rxn	Subscript indicating a biological or chemical reaction of the solute (other than sorption) [$\text{mg L}^{-1} \text{ hr}$]
S_2	Solid phase concentration at site 2
V	Average velocity of groundwater flow [cm hr^{-1}]
v_x	Average linear groundwater velocity [cm hr^{-1}]
t	Time [hr]
α	First-order mass transfer coefficient [d^{-1}]
α_L	Longitudinal dynamic dispersivity [cm]
α_T	Transverse dynamic dispersivity [cm]
θ	Volumetric moisture content or porosity for saturated media [-]

β	Parameters used in CXTFIT and related to f
ω	Parameters used in CXTFIT and related to α