Release of vanadium from LD-slag by exposure to ARD

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VIKTOR SJÖBERG[1,*], STEFAN KARLSSON[1] & LOTTA SARTZ[1,2]

[1]MAN-TECHNOLOGY-ENVIRONMENT RESEARCH CENTRE
ÖREBRO UNIVERSITY, SE-701 82 ÖREBRO SWEDEN

[2]BERGSKRAFT BERGSLAGEN, HARALD OLSGATAN 1
SE-714 31 KOPPARBERG SWEDEN

*VIKTOR.SJOBERG@ORU.SE
WWW.ORU.SE/FORSKNING/FORSKNINGSMILJOER/MILJO/MTM/

Introduction

MINING

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GENERATES WASTE MATERIALS
- e.g. parent bedrock & ore residues

SULPHIDE ORE RESIDUES
- abiotic and microbial weathering generates acid rock drainage (ARD)

Introduction

ABATEMENT OF ARD

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WANTED:
- high neutralizing capacity
- low cost

ONE POTENTIAL CLASS OF MATERIALS
- steel slags
- e.g. LD-slag

Introduction

LD-SLAG CHARACTERISTICS

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HIGH CONTENT OF ALKALINE OXIDES
- 45 % CaO
- 24 % FeO
- 12 % SiO

MAJOR DRAWBACK
- 0.17 % Cr
- 2.66 % Mn
- 2.68 % V

Introduction

VANADIUM FACT

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- probably an essential trace element up to µg l^{-1}
- toxic above (50 µg l^{-1})
- vanadium (V) most toxic
- pe-pH dependent redox chemistry
- vanadium content in LD-slag is high enough to poison heifers

Aim

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To determine the two most abundant and toxic vanadium species, i.e. vanadium (IV) and vanadium (V), leached from LD-slag by exposure to ARD.

Materials & Methods

SETUP

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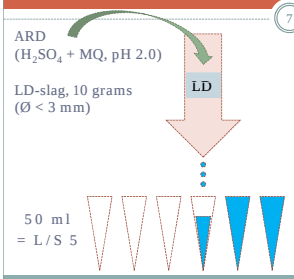

After sampling:
- pH
- prep. for ICP-MS analysis (acidification, 1 % HNO_3)
- speciation V(IV) and V(V) (filtered samples)
- Storing (dark, 4 °C / 39 °F)

Materials & Methods

SPECIATION V(IV) AND V(V)

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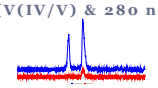
- Capillary Electrophoresis (CE)
- EDTA-complexation, phosphate buffer pH 4.0
- UV-determination: 191 nm (V(IV/V) & 280 nm (V(V))



- concentration calculated from standard curve and confirmed by standard addition

Results & Discussion

pH-DROP AND EQUILIBRIUM MODELING

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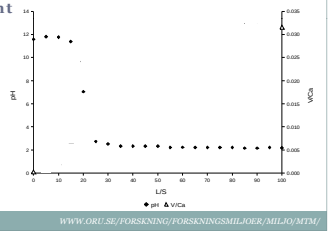
- ANC = 2-3 % CaO content
- possible reasons:
  * $Ca(OH)_2$ and $CaCO_3$
  * kinetics
  * dense coatings
- PHREEQC indicates:
  * $CaSO_4$



Results & Discussion

SURFACE COATINGS AND V/Ca RATIO

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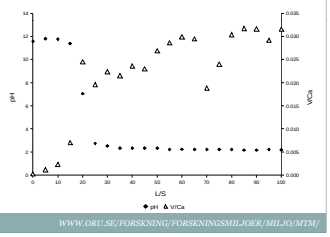
- $Ca(OH)_2$ and $CaCO_3$
- increasing V/Ca ratio up to L/S 20
  * alkaline surface free from vanadium
- stable V/Ca ratio beyond L/S 20
  * equilibrium with non-weathered LD



Results & Discussion

VANADIUM SPECIATION

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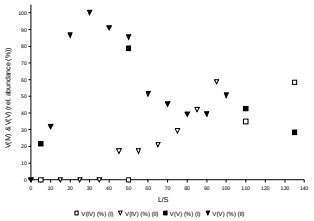
- Changes of species
  * increasing V(IV)
  * decreasing V(V)
- 10 days storing
  * increases V(IV)
  * decreases V(V)



Conclusions

VANADIUM FROM LD-SLAG

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- vanadium releases, ~ 3 ppm
- potential environmental threat
- immediate analysis necessary
- species-specific methods must be used to evaluate environmental risks
- pe-pH dependent chemistry
- release also confirmed by a field study in progress Sartz L et al.