

Manganese Recovery: Missouri River Nodules

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Research Experience for Undergraduates – Summer 2010

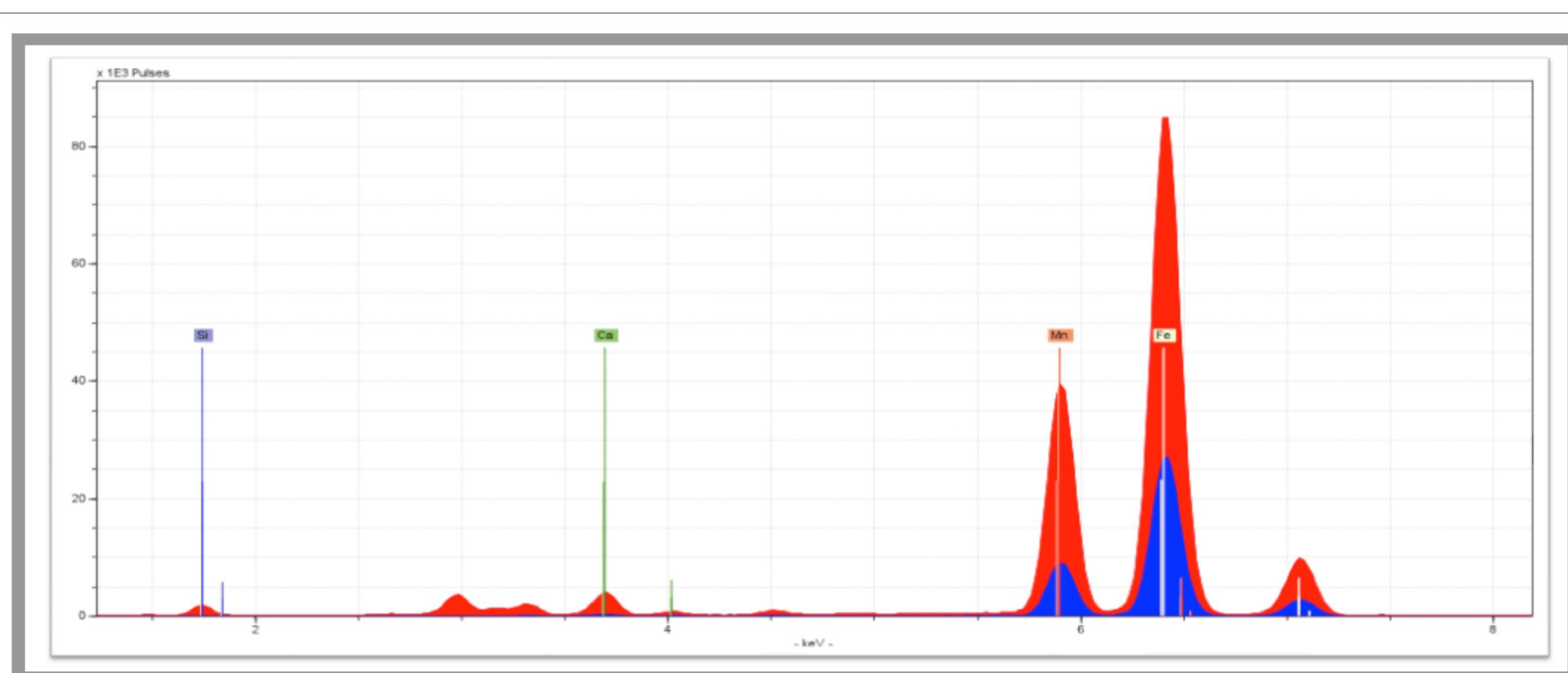


Abstract

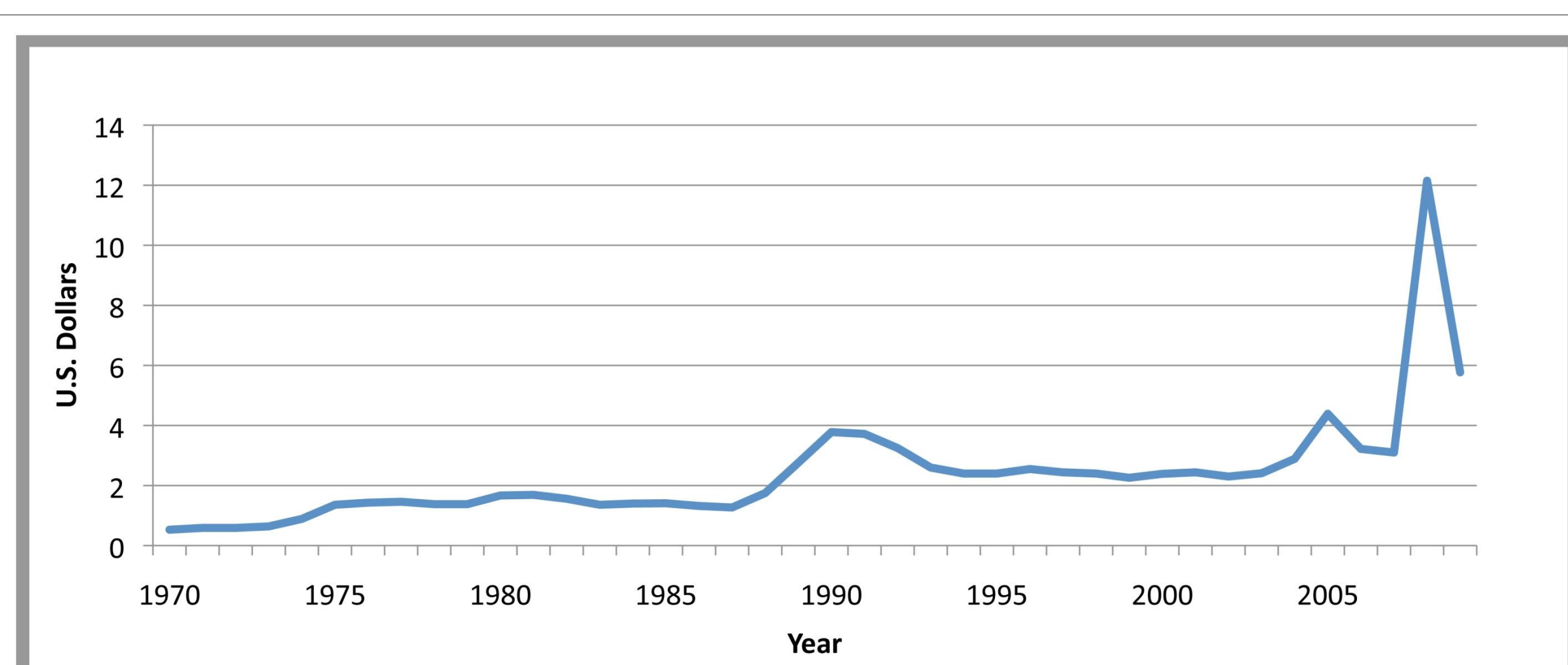
A low-grade manganese deposit exist along the Missouri river in central South Dakota, primarily on Lower Brule Reservation Land. This deposit has been evaluated as the largest manganese deposit in North America. This ore deposit has been investigated previously and generally found to be uneconomical. This was partially due to expected high extraction costs and to a relative lack of demand. Currently, the US is essentially 100% dependent on foreign sources for manganese. A recent National Research Council study indicated that the impact of manganese supply restriction is high and the supply risk was above average. Recently, the price of manganese has increased sufficiently that, coupled with newer, lower-cost, processing technologies, the mining, extraction and production of manganese may be profitable. An additional bonus is the existence of a relatively nearby steel operation (Nucor Steel, Norfolk, NE) interested in possibly utilizing this material.

Objectives

- Analyze soil samples from manganese deposit in central South Dakota.
- Produce a metallurgical process to concentrate manganese ore.
- Investigate mining aspects associated with a future manganese mine of the Missouri River nodules



X-Ray Fluorescence (XRF) Results



Annual Average Price of 48%-50% Manganese Ore Per 10 kg

Procedure

Analyzing Soil Samples

- Collect rocks from 43° 49'14"N, 99° 23'44"W.
- Crush samples using jaw crusher, double-roll crusher, and a dry ball mill.
- Analyze size distribution after each size reduction method.
- Conduct x-ray diffraction tests on soil samples.
- Conduct x-ray fluorescence tests on soil samples.

Produce a Metallurgical Process to Increase Rhodochrosite Concentration

- Research the processing of similar ore bodies.
- Test gravity separation using a Wilfley shaking table.
- Test using flotation to separate ore from gangue.
- Test the benefits of using magnetic separation on ore samples.

Investigated Mining Aspects Associated with a Future Manganese Mine

- Research past investigations of placing a mine in central South Dakota.
- Research how a harsh winter climate could affect mining operations.

Results

Composition of Original Sample Using X-Ray Diffraction

- Dolomite $\text{CaMg}(\text{CO}_3)_2$ 66.4 % by weight
- Rhodochrosite MnCO_3 30.6% by weight
- Quartz SiO_2 2.9% by weight

Composition of Original Sample Using X-Ray Fluorescence

- Same elements as XRD
- A significant amount of iron (percentage unknown at this time)

Flotation Results

- Were able to concentrate Rhodochrosite concentration by 43.3%
- Tailings from the flotation consisted of 89.1% Dolomite and only 5.0% Rhodochrosite.

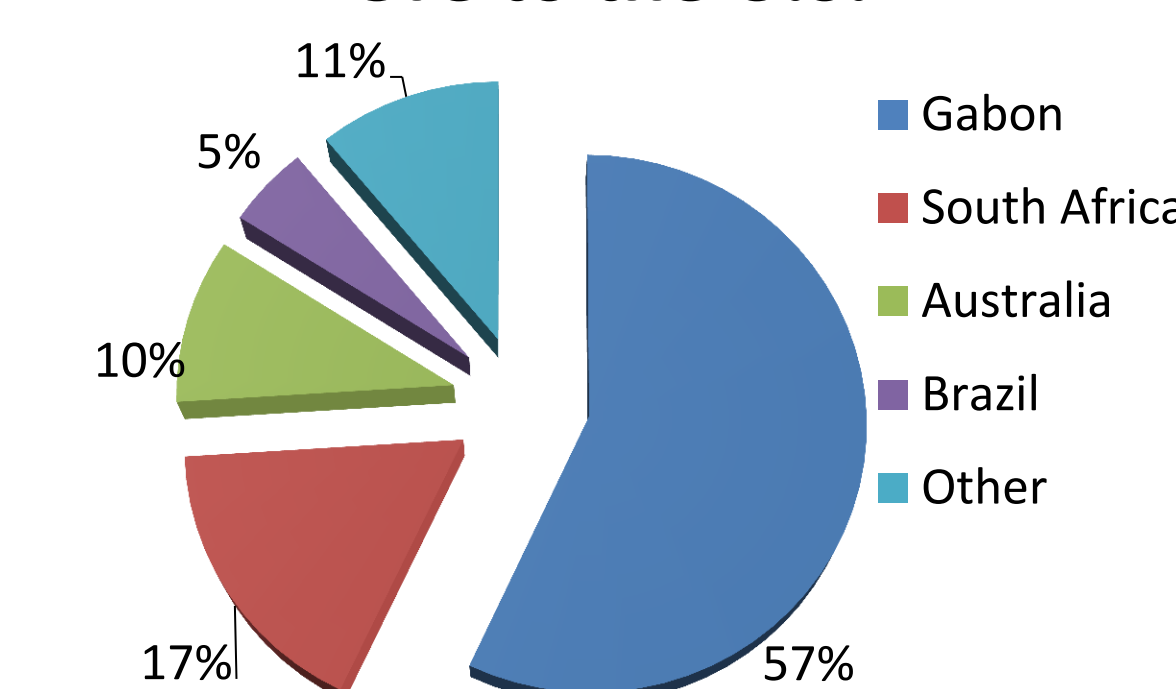
Gravity Separation Results

- Specific gravities proved to be to similar and testing proved inconclusive.

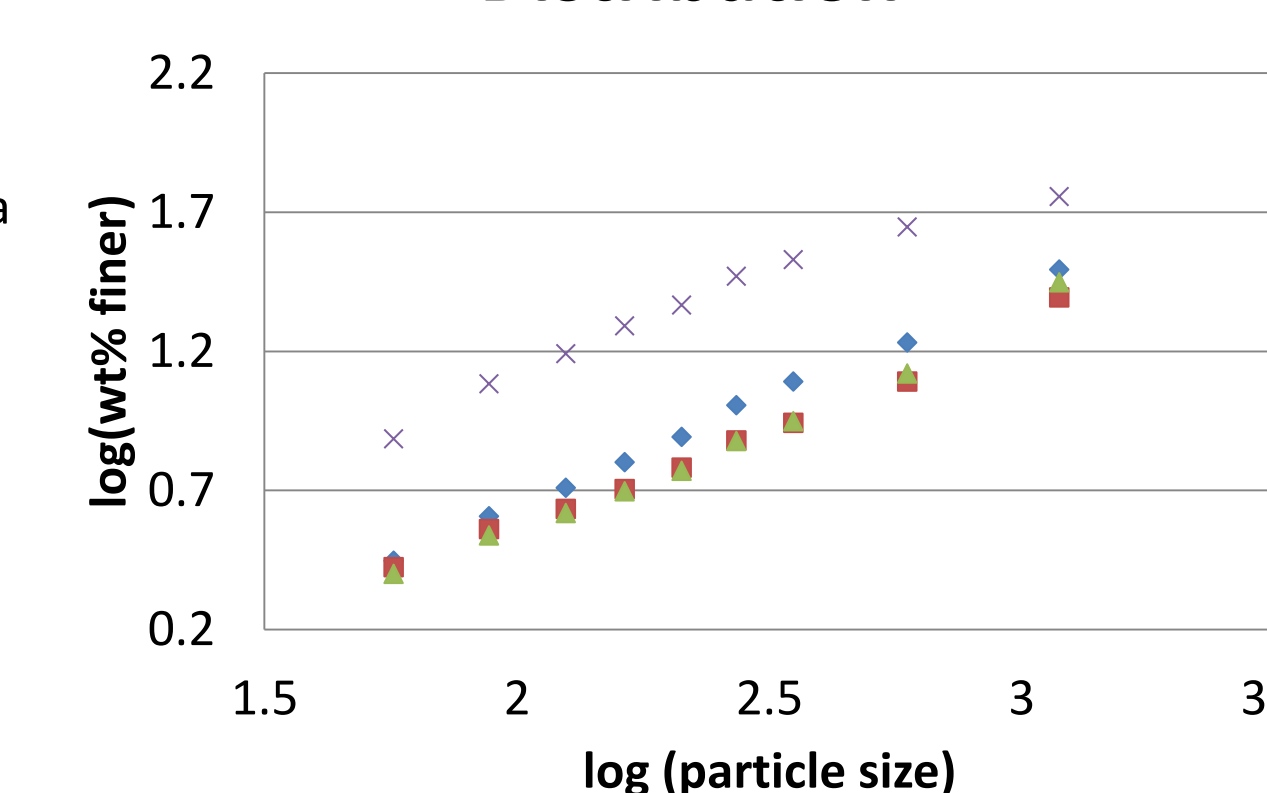
Broader Impact

Manganese is an essential element in today's society. Its most significant impact is its use in the construction of steel which accounts for 80-90 percent of manganese consumption. Other known uses include paint pigments, dry cell and alkaline batteries, animal feed, glass production, fertilizers, and many medical and health applications. A manganese mine that extracted ore from the Missouri River nodules would benefit United States' steel producers by lowering shipping costs, create American jobs, and present a reliable source of manganese in critical times.

Import Sources of Manganese Ore to the U.S.



Roll Crusher Size Distribution



Abandoned mine that extracted manganese ore from Missouri River nodules in the late 1930's to 1947.

Conclusion

- In lab scale test we were able to manufacture a manganese ore grade sufficient for sale.
- Had best results with the use of flotation separation.
- Determined size distribution of crushed ore samples.
- A manganese sources in the United States would lead to a decrease concern of acquiring this strategic metal.
- Gathered ore deposit characteristics vital to mine construction.
- A surface mine should be sufficient for accessing ore deposits.

Future Work

- Determine a more accurate evaluation of extent, location, and value of the manganese ore body.
- Evaluate financial viability of Missouri River manganese nodules.
- Perform large scale ore processing tests.
- Produce a purer form of manganese ore.
- Investigate the construction of ferromanganese using Missouri River manganese nodules

Acknowledgements

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