Historical Exposure Reconstruction in the Taconite Mining Industry - Study Design

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1. Geologic mapping in the Mesabi Iron Range

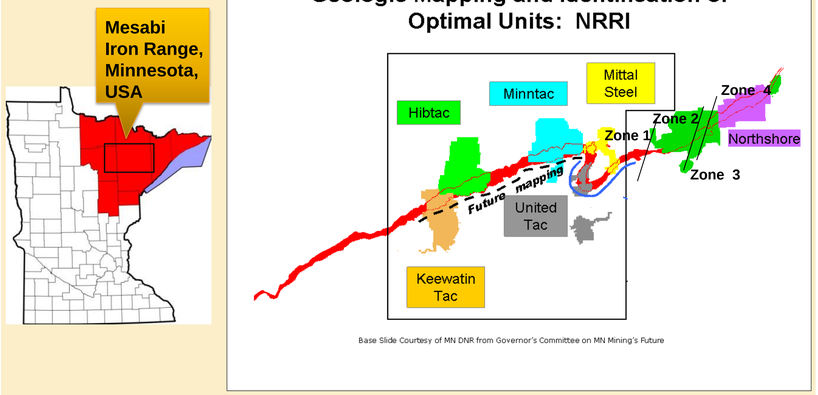


Fig 1. Location map of Minnesota taconite mines and metamorphic change in mineralogy from west to east across the Mesabi Iron Range, relative to taconite mining operation locations (www.nrri.umn.edu)

2. Mineralogical differences analysis

Eastern Mesabi Iron Range	Western Mesabi Iron Range
Northshore	Keewatin Tac, Hibtac, Minntac, Mittal Steel, and United Tac.
Unaltered taconite	**Highly metamorphosed** taconite
Amphiboles are prevalent. e.g. quartz, iron amphiboles (grunerite - cumingtonite, hornblende), iron pyroxenes (hedenbergite, ferrohypersthene), magnetite.	**Phyllosilicates are prevalent.** e.g. quartz, magnetite, hematite, siderite, carbonates, talc, iron-silicates (chamosite, greenalite, minnesotaite and stilpnomelane).
Regulated as (amosite) asbestos.	**Not regulated** as asbestos.

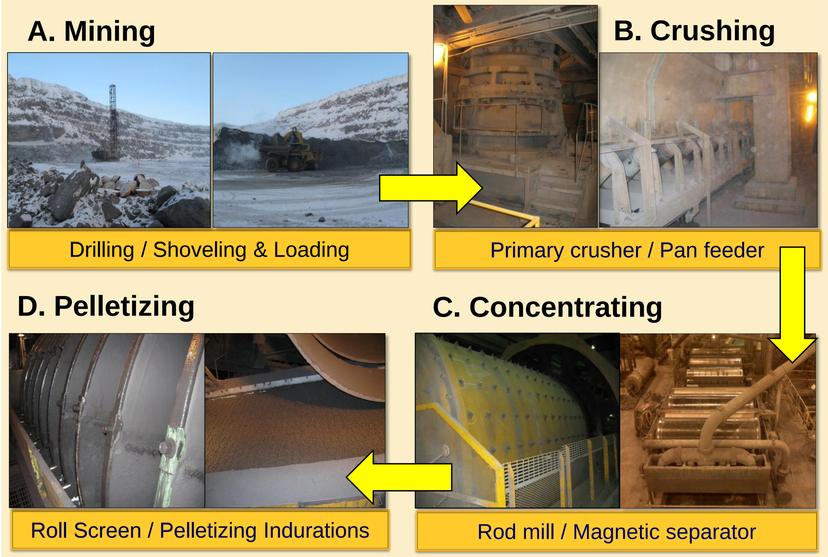
3. Create Similarly Exposed Groups (SEGs)

MSHA (~190 job titles)
Previous UMN (138 job titles)
Companies (~150 job titles)
+
Preliminary Survey
Expert Judgment
Historical data analysis
=
~30 SEGs

4. Specific purpose

1. Assess historical exposure of workers to taconite dust from taconite companies between 1955 and the present to evaluate the relationship between exposures and health effects.
2. Assess current exposure of workers to taconite dust components from taconite operations in relation to current occupational exposure limits.
3. Evaluate existing practices and methods to reduce exposure in the taconite industry and where appropriate, suggest improvements in these methods.

5. Taconite Process Flow



6. Reconstruction of Historical Exposure

Data sources

MSHA, MSHAP, MDH, Previous studies from UMN,

Internal Database from Mining Companies:
Cleveland Cliffs
U.S. Steel
ArcelorMittal

Job Exposure Matrix	Job title, Job location, Year, Duration of shift, Type of process, Task
Data	Exposure Monitoring data, Ventilation rate, Dust generation rate, Production rate
Health-relevant components of dust	Asbestos fibers, Non-asbestos fibers, Respirable dust, Respirable silica

Note: MSHA – Mine Safety and Health Administration
MSHAP – Mineral Resources Health Assessment Plan
MDH – Minnesota Department of Health

7. Combination of Exposure Assessments

1. Available measurements over the time period of interest.
   To characterize the exposure distribution of asbestos and non-asbestos fibers, respirable dust and respirable silica
2. Exposure modeling
   To describe exposure to taconite manufacturing from source to receptor.
3. Interviews with plant personnel and veteran workers
4. Statistical modeling
   1) ANOVA analysis will help to create exposure data matrix
   2) Bayesian method will be used to reconstruct historical exposure that fills up incomplete measurement and to determine exposure as a function of time

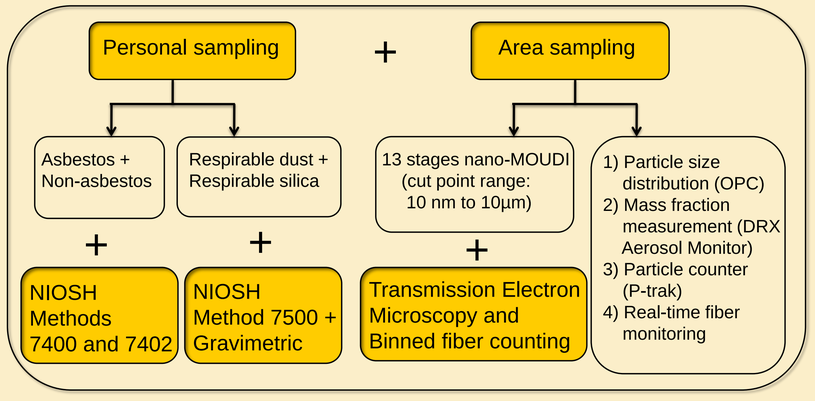
8. Historical exposures of workers as a function of time

Species 1				
Years	1955-1960	1960-1965	…	2005-2009
Job 1	E11	E12		E1*
Job 2	E21	E22		E2*
Job 3	E31	E32		E3*
Etc.				

Worker A
Employment History
mm/dd/yyyy site 1
mm/dd/yyyy site 2
Health History
Mm/dd/yyyy hospitalized xx
Mm/dd/yyyy surgery on xx

Statistical Analysis
Dose-Response Relationship

9. Sampling Strategy for Current Exposure



Note: NIOSH Method 7400 – Asbestos and other fibers by Phase Contrast Microscopy
NIOSH Method 7402 – Asbestos by Transmission Electron Microscopy
NIOSH Method 7500 – X-ray Diffraction

Western : 30 SEG X 8 workers / SEGs X 3 samples / worker = 720 samples
Eastern : 30 SEG X 2 workers / SEGs X 3 samples / worker = 180 samples

1. 8 workers will be spread over 5 mines. Thus, 2 workers for three of the mines and 1 worker for the two remaining mines.
2. The sampling design will allow to analyze for
   1) Variability within workers
   2) Variability within SEGs
   3) Variability between workers in a SEG within a mine
   4) Variability between workers in a SEG across a mine
   5) Variability between zones
   6) Variability within mines in each zone

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