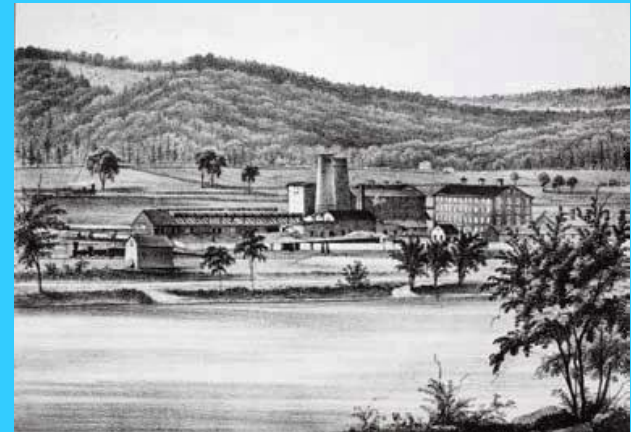
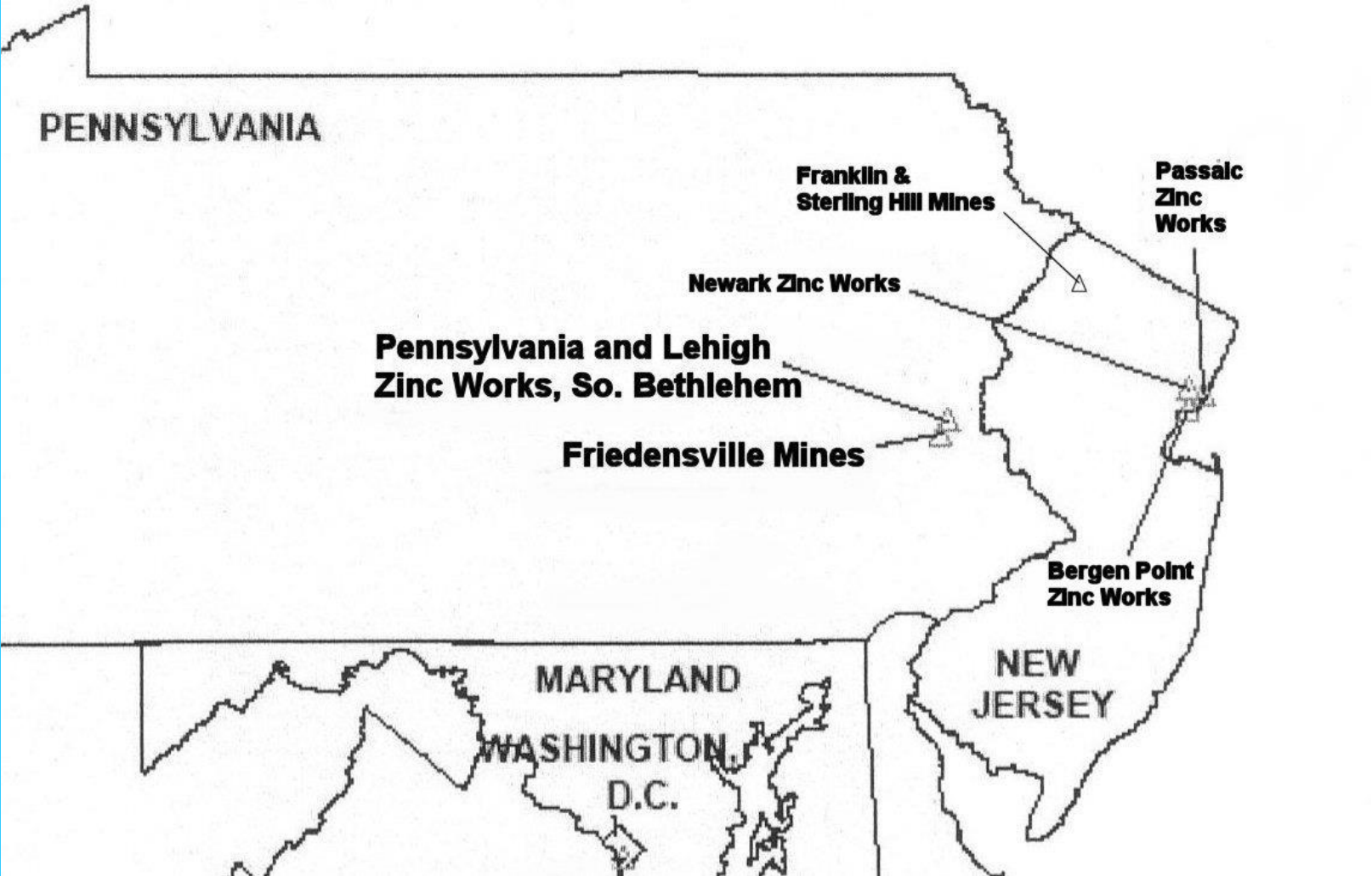


19th CENTURY ZINC MINING IN THE FRIEDENSVILLE, PA DISTRICT AND THE BIRTH OF THE U. S. ZINC INDUSTRY

L. Michael Kaas
Society for Industrial Archaeology, June 2, 2018



ZINC MINES AND SMELTERS, 1850-1890



(Modified from Bleiwas and DiFrancesco, 2010)

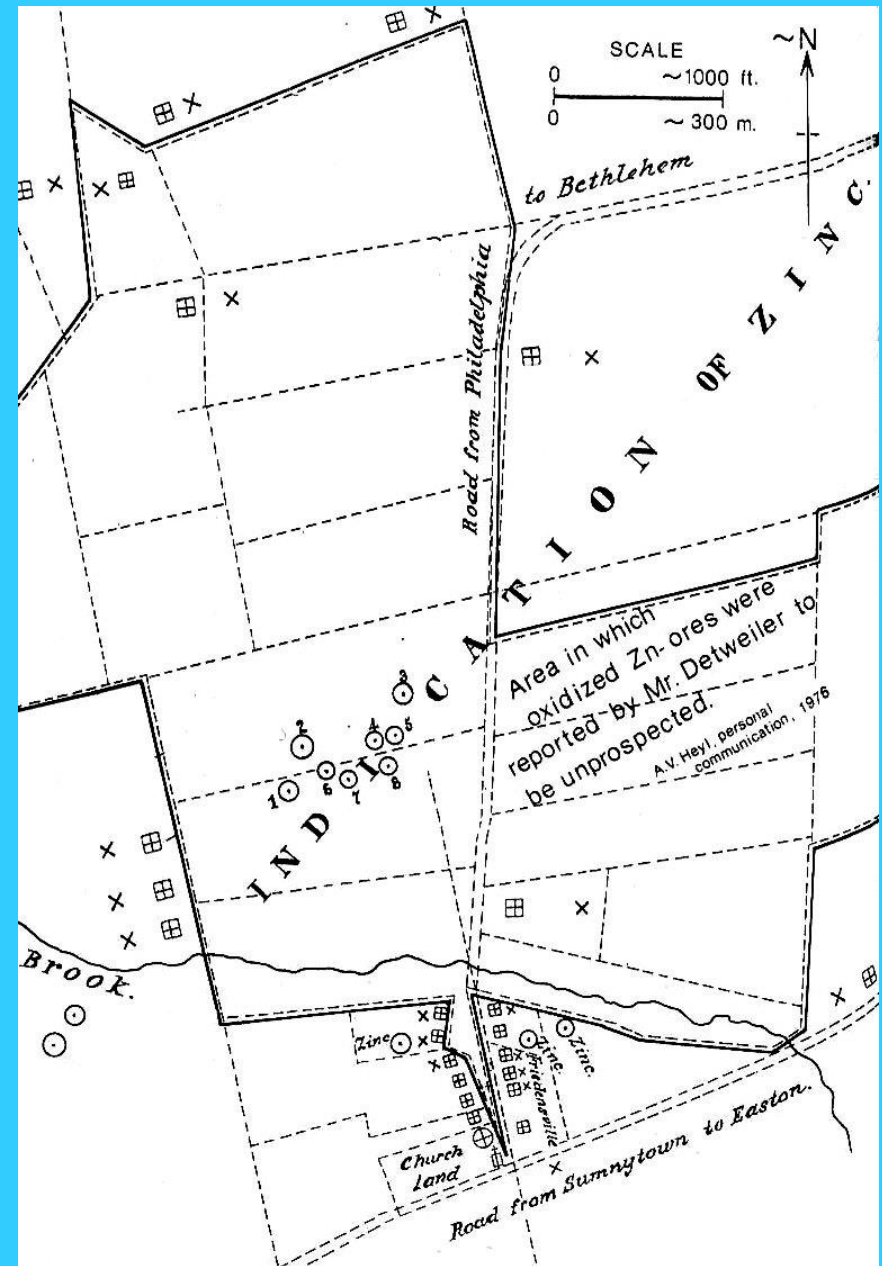
1847 EXPLORATION MAP FRIEDENSVILLE, PA

REFERENCES.

- ⊞ × Buildings and outbuildings
- ⊞ Church.
- ⊕ Schoolhouse.
- ⊙ Shafts.

N ^o 1 Shaft.	37 feet.	Depth through zinc ore	31 feet.
2	42	"	30
3	13	"	9
4	53	"	46
5	27	"	16
6	30	"	22
7	33	"	24
8	22	"	12

In none of the Shafts has the zinc ore been penetrated. (That is, the bottom is in ore)



(Wittman, 1847; Smith, 1977)

SAMUEL WETHERILL

FAMILY LEAD WORKS, PHILA.
 CHEMIST, N J ZINC CO.
 SUPT. NEWARK ZINC WORKS
 PATENTS ZINC OXIDE FURNACE



Samuel Wetherill as a Young Man
 (South Bethlehem Historical Society)

UNITED STATES PATENT OFFICE.

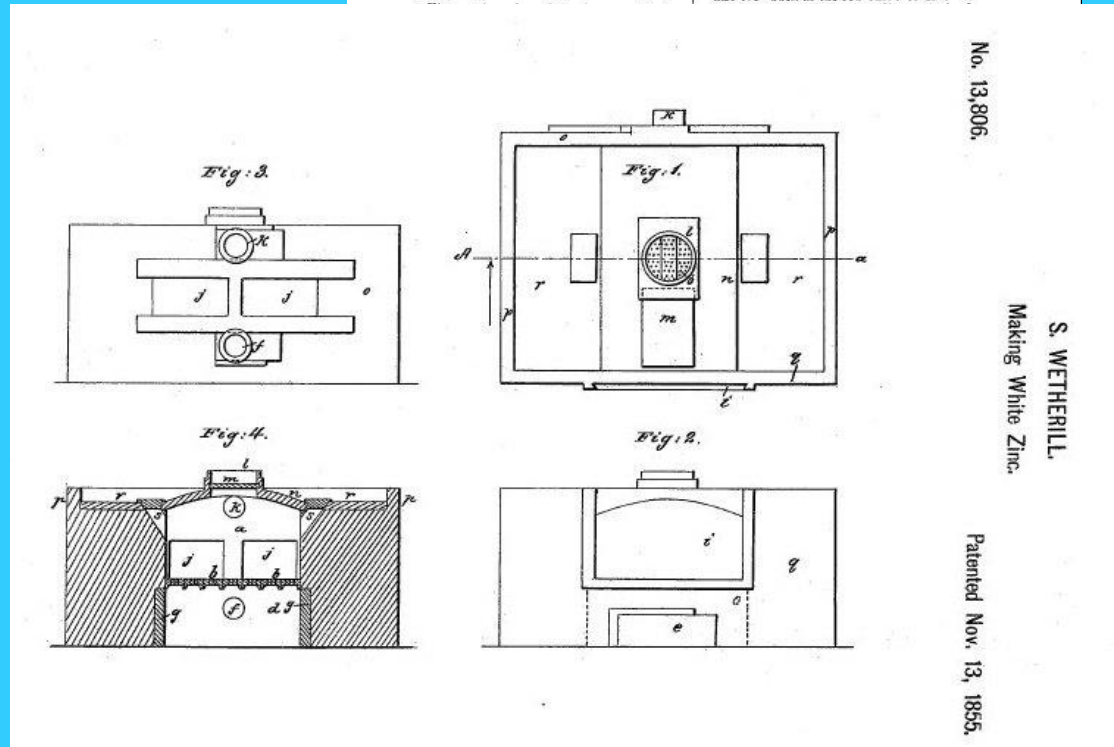
SAMUEL WETHERILL, OF BETHLEHEM, PENNSYLVANIA.

IMPROVEMENT IN PROCESSES FOR MAKING ZINC-WHITE.

Specification forming part of Letters Patent No. 13,806, dated November 13, 1855.

To all whom it may concern:
 Be it known that I, SAMUEL WETHERILL, of Bethlehem, in the State of Pennsylvania, have invented a new and useful Improvement in the Process of Reducing the Ores of Zinc and Producing Therefrom the White Oxide of Zinc; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, making part of this specification, in which—

pheric air introduced in numerous small jets to the charge of mixed ore and fuel in a thin layer, whereby the carbon and heat required for the decomposition of the ore and the heat required for the evaporation of the metal are all derived from the coal or other carbonaceous matter in admixture with the ore, while the blast of atmospheric air supplies the oxygen required for the combustion and for the oxidation of the metallic vapors.
 The ore—such as the red oxide of zinc—is



1853 WETHERILL AND GILBERT ZINC WORKS, SOUTH BETHLEHEM, PA

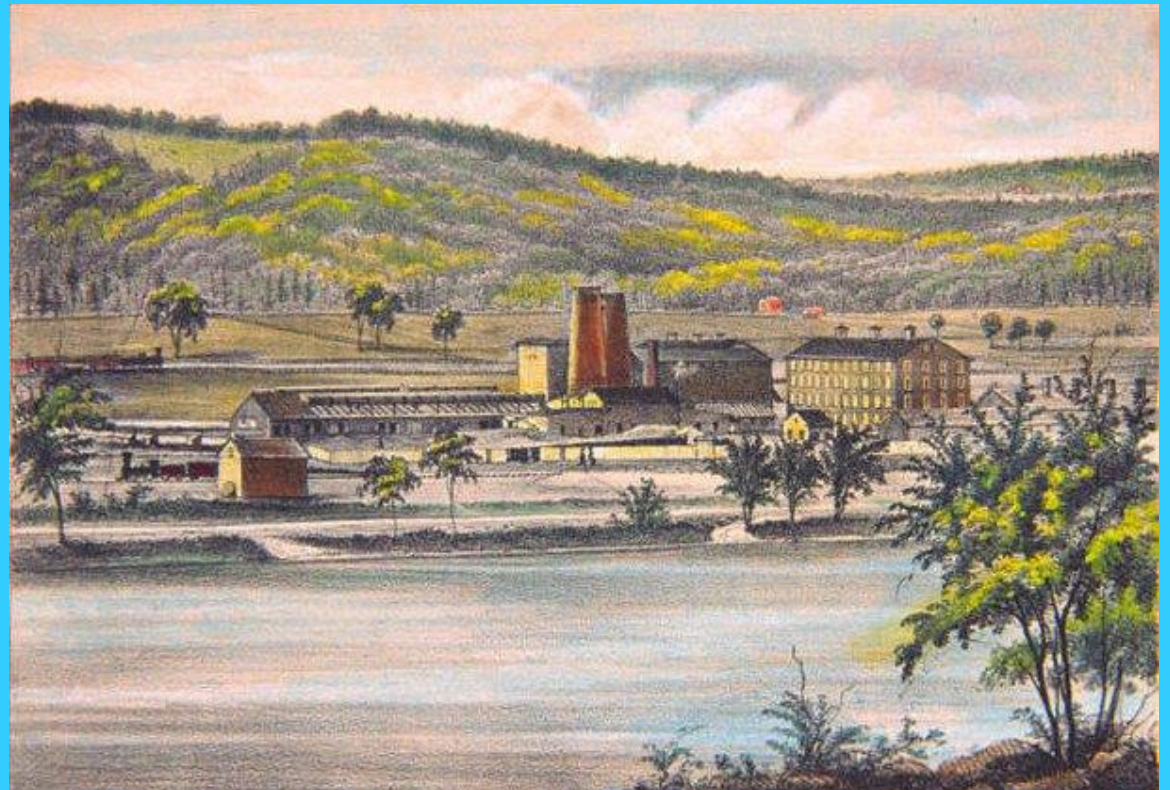
PENNSYLVANIA AND LEHIGH ZINC COMPANY (PLZC) OPERATES THE FRIEDENSVILLE MINES, CONTRACTS WITH WETHERILL FOR OXIDE

WETHERILL PROCESS: WETHERILL'S OXIDE FURNACE PATENT
SAMUEL T. JONES' BAG HOUSE PATENT

FIRST* U.S.
LARGE SCALE
ZINC OXIDE
PRODUCTION

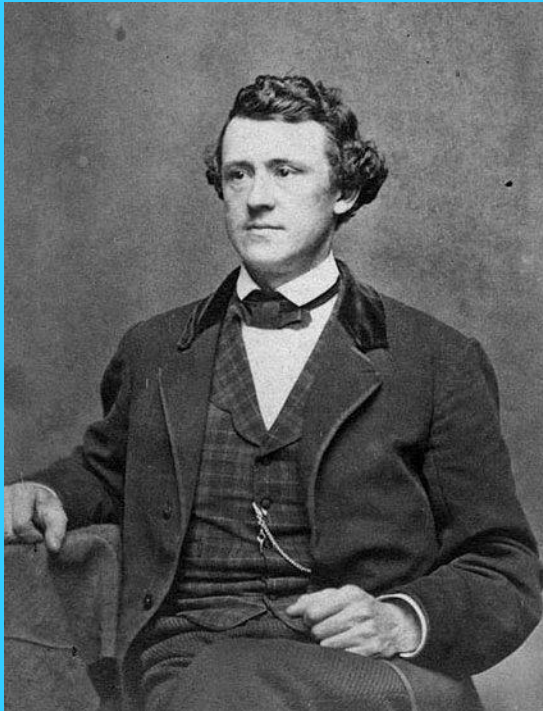
* New Jersey Zinc and Passaic Zinc were producing smaller amounts of oxide from Franklin-Sterling Hill Ores using other processes

(Henry, 1860)



1854 PHILADELPHIA QUAKER INVESTORS TAKE OVER PLZC

**JOSEPH WHARTON SENT
TO OVERSEE OPERATIONS**



Joseph Wharton, ca1850 (Wikipedia, 2013)

PROBLEMS WITH WETHERILL

DECLINING QUALITY OF OXIDE

SALE OF OXIDE FOR OWN ACCOUNT

USE OF COMPANY RESOURCES FOR
EXPERIMENTS IN MAKING SPELTER
(METALLIC ZINC)

WHARTON'S ACTIONS

IMPROVES MANAGEMENT

INCREASES PROFITABILITY

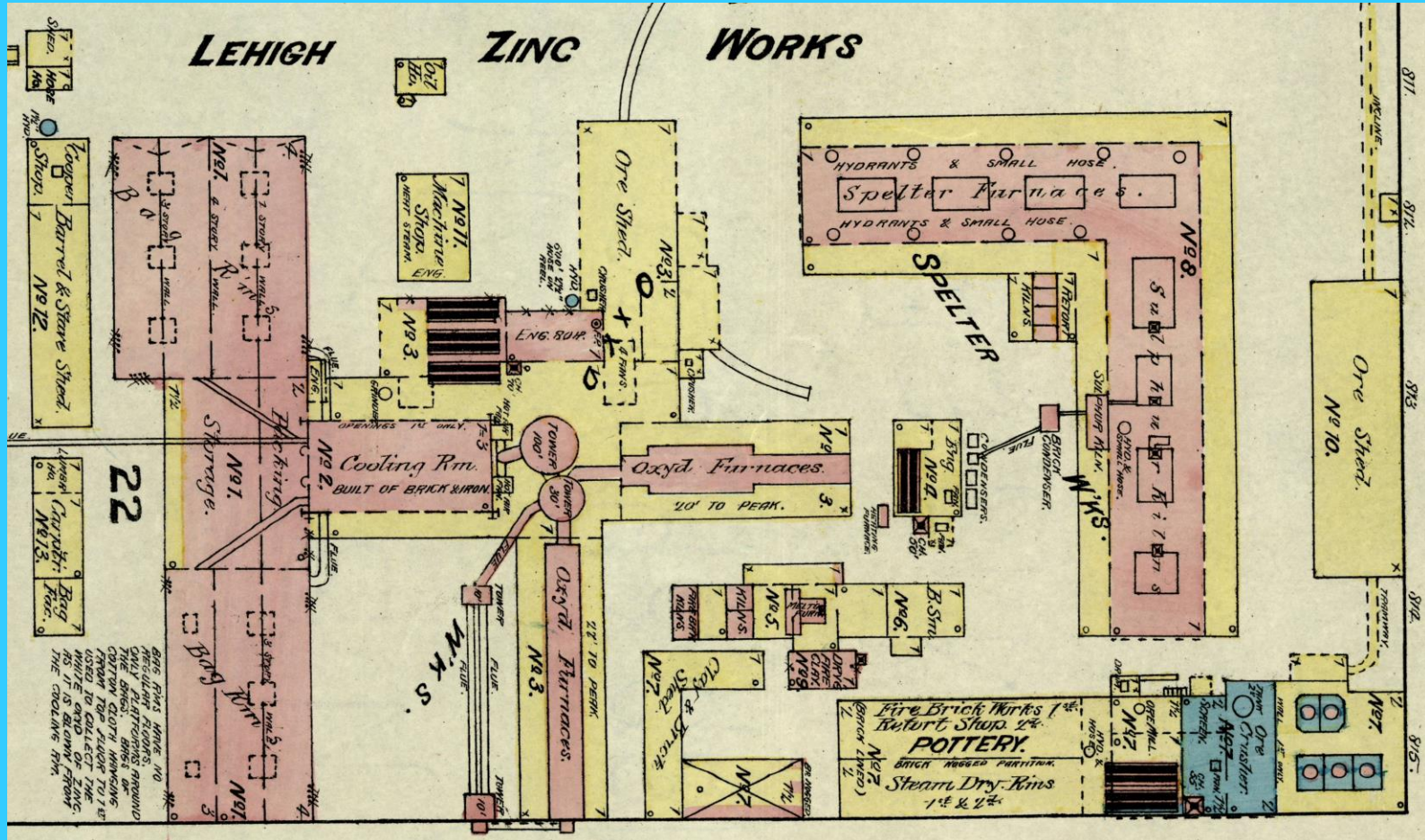
HIRES "COMPETENT MINER" TO RUN
THE MINES (**RICHARD W. PASCOE**)

WETHERILL SELLS OUT

**WHARTON CONSTRUCTS AND OPERATES FIRST COMMERCIAL
METALLIC ZINC SMELTER IN THE U. S. (1860-1863)**

1861-1865 CIVIL WAR, ZINC DEMAND AND PRICE INCREASES

WHARTON BECOMES A WEALTHY MAN, LEAVES ZINC IN 1863



(1885 Sanborn Insurance Map)

THE FRIEDENSVILLE MINES, 1853-1893

Pennsylvania and Lehigh Zinc Co. /
Lehigh Zinc Co.* (1853-1876/1881)

Uberroth Mine

Old Hartman Mine

Three Cornered Lot Mine

New Hartman Mine

Passaic Zinc Co. (1853-1875)

Correll Mine

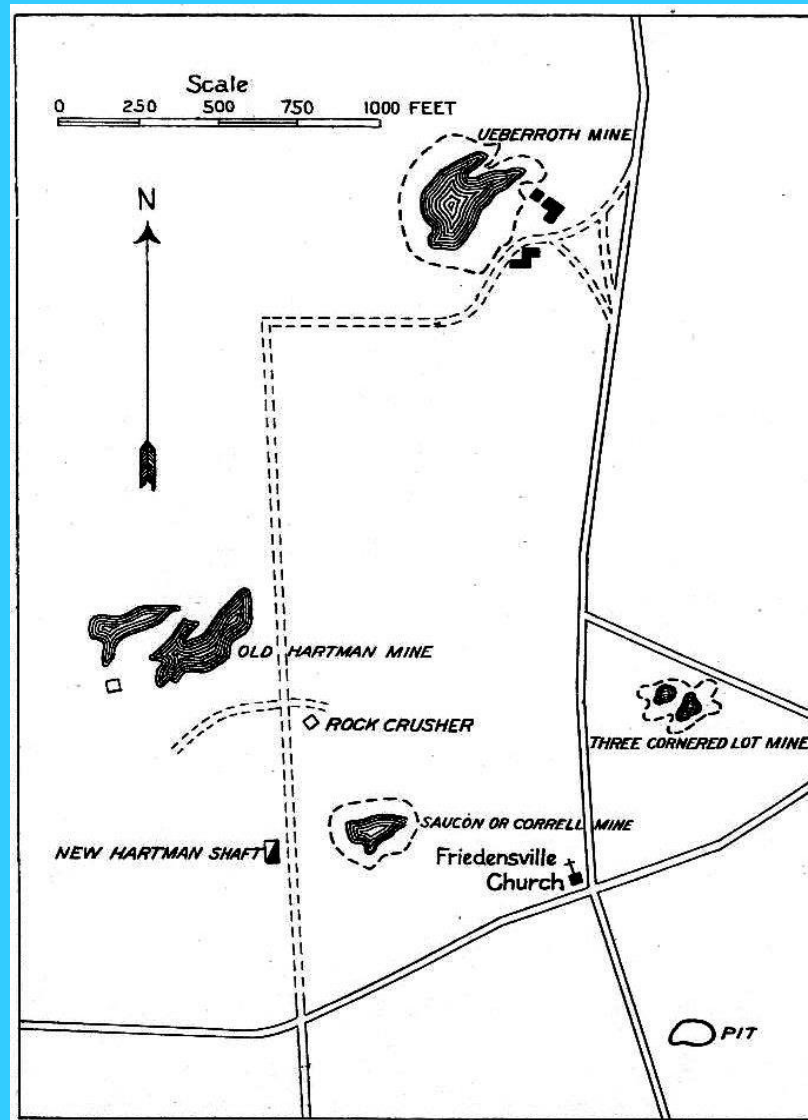
Bergen Point Zinc Co. (1875-1881)

Correll Mine

Friedensville Zinc Co. (1881-1893)

All Mines

* PLZC changed its name to LZC in 1860



(Miller, 1924, Figure 4)

FRIEDENSVILLE MINERALS

Near the Surface

Hemimorphite ($\text{Zn}_4\text{Si}_2\text{O}_7(\text{OH})_2 \cdot \text{H}_2\text{O}$)

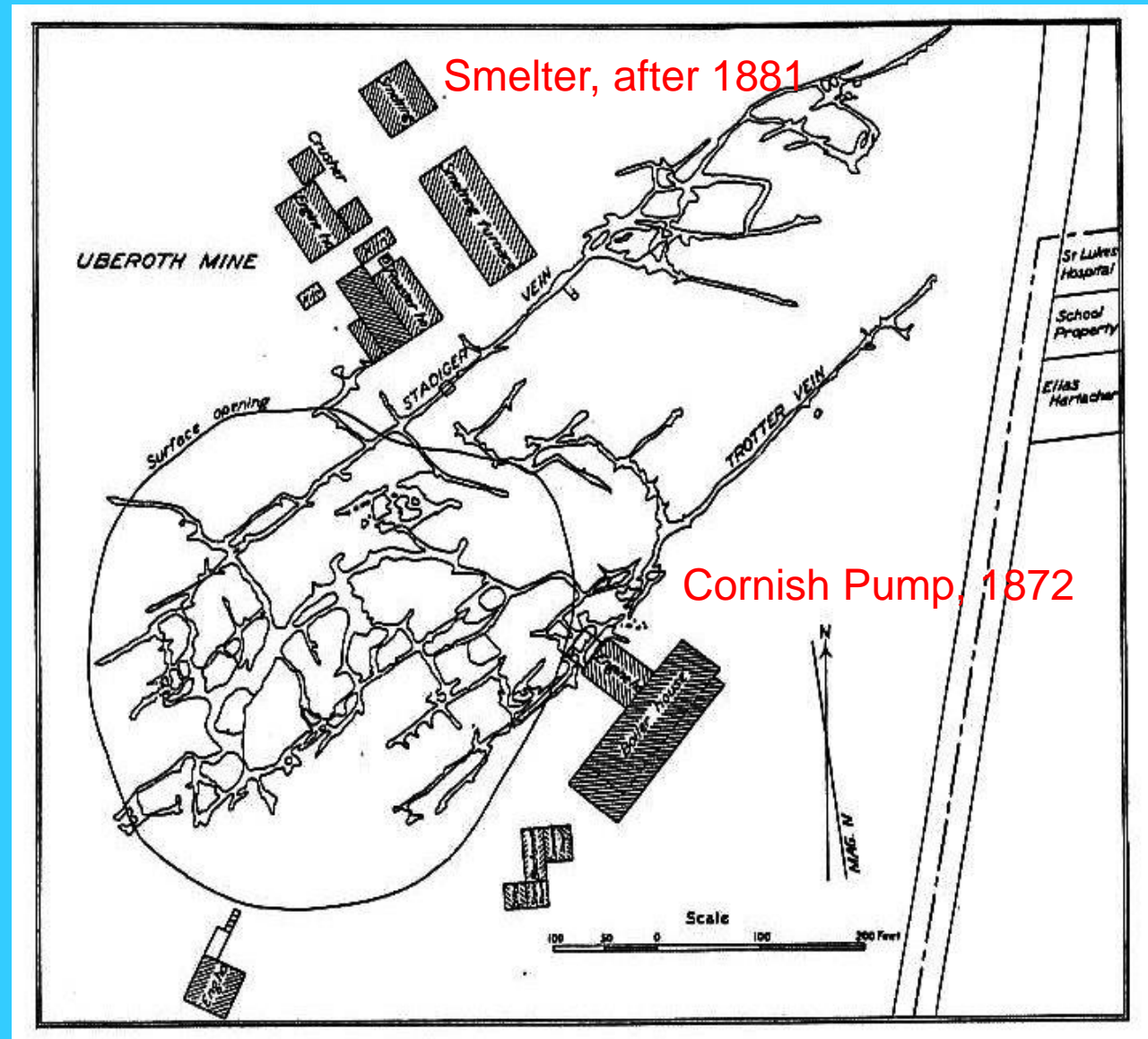


Deeper Underground

Sphalerite (ZnS)



UBERROTH MINE



(Miller, 1924, Figure 5)

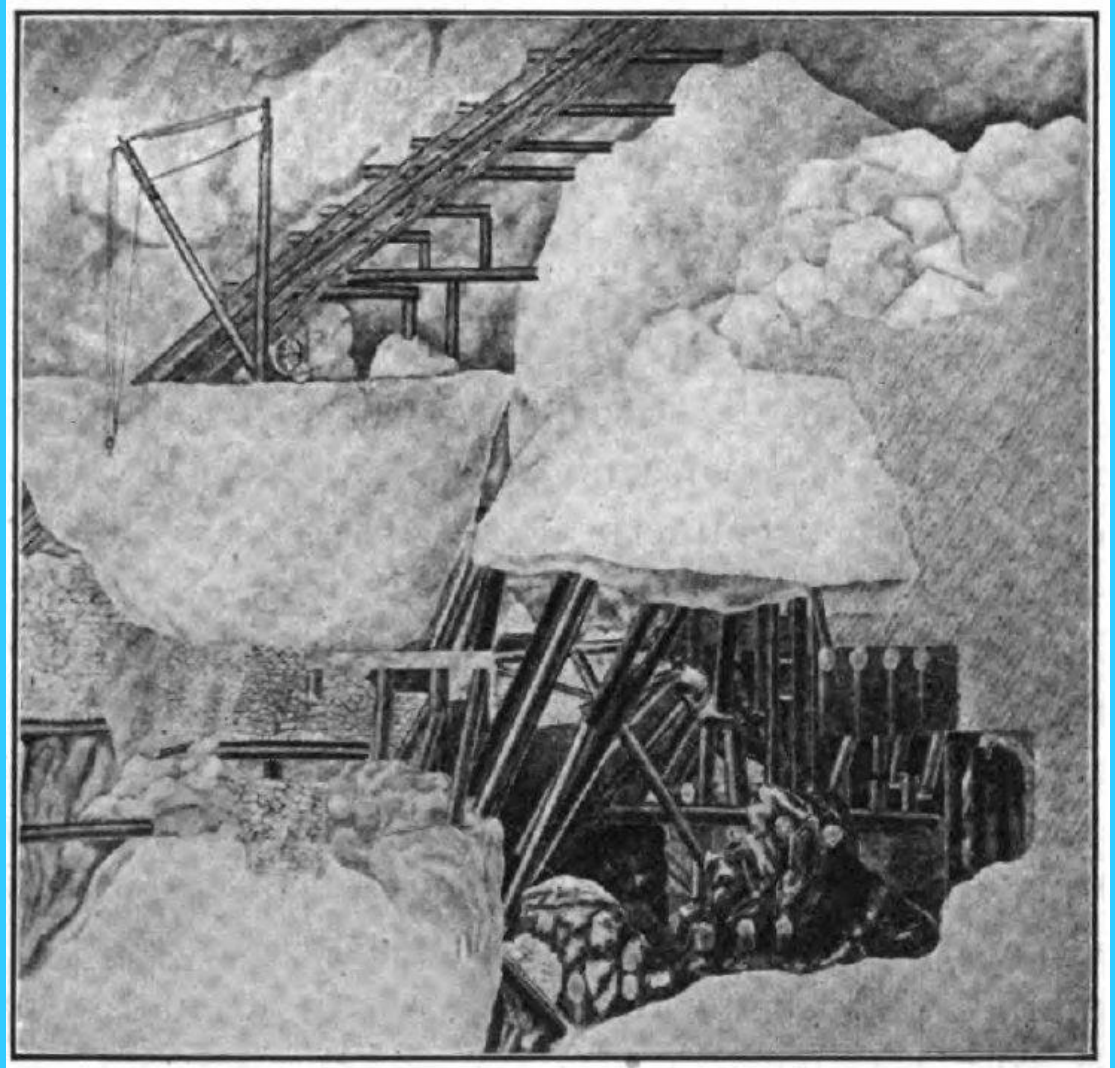
UBERROTH UNDERGROUND MINING METHODS

ZINC ORE SURROUNDED
BLOCKS OF LIMESTONE
AND DOLOMITE

MINERS TRIED TO TAKE
ONLY THE ORE

TIMBERS USED TO
SUPPORT THE BLOCKS
WHEN ORE WAS REMOVED

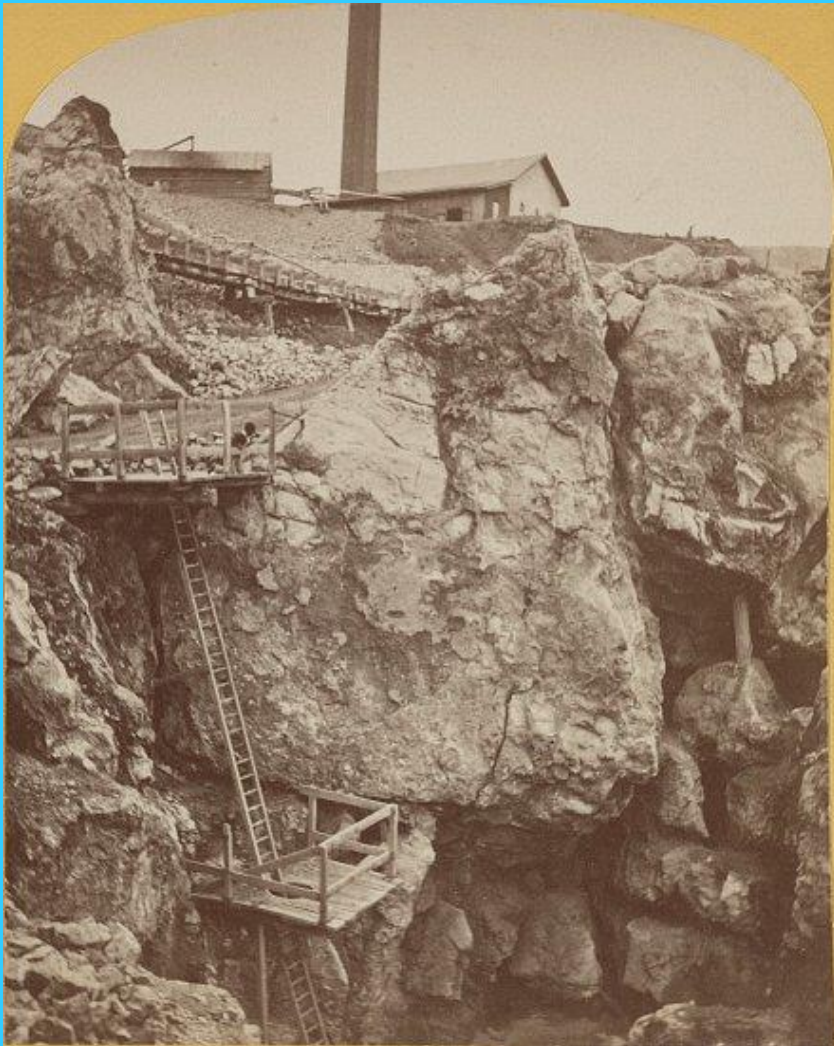
INCLINED RAMP USED TO
TRANSPORT ORE TO THE
SURFACE (NO MAIN SHAFT
EXCEPT FOR PUMPING
WATER)



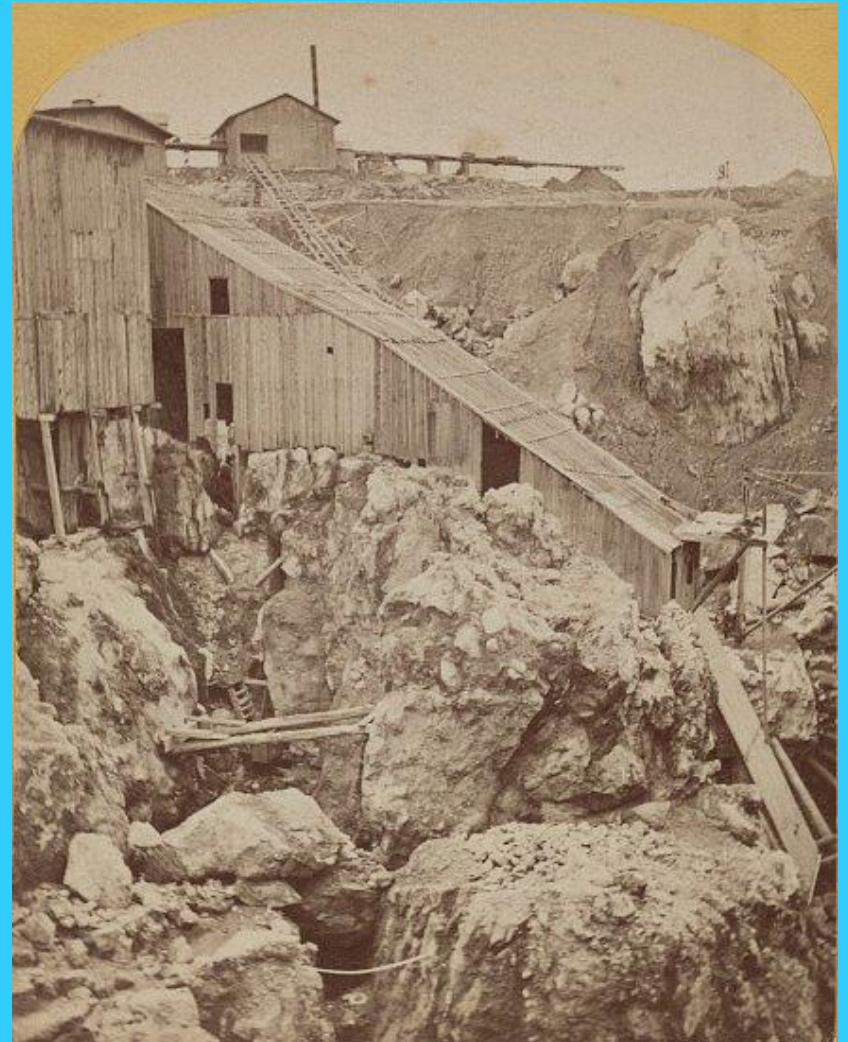
(Painting ca1880; AIME, 1925)

UBERROTH UNDERGROUND MINING METHODS

MINERS CLIMB LADDERS

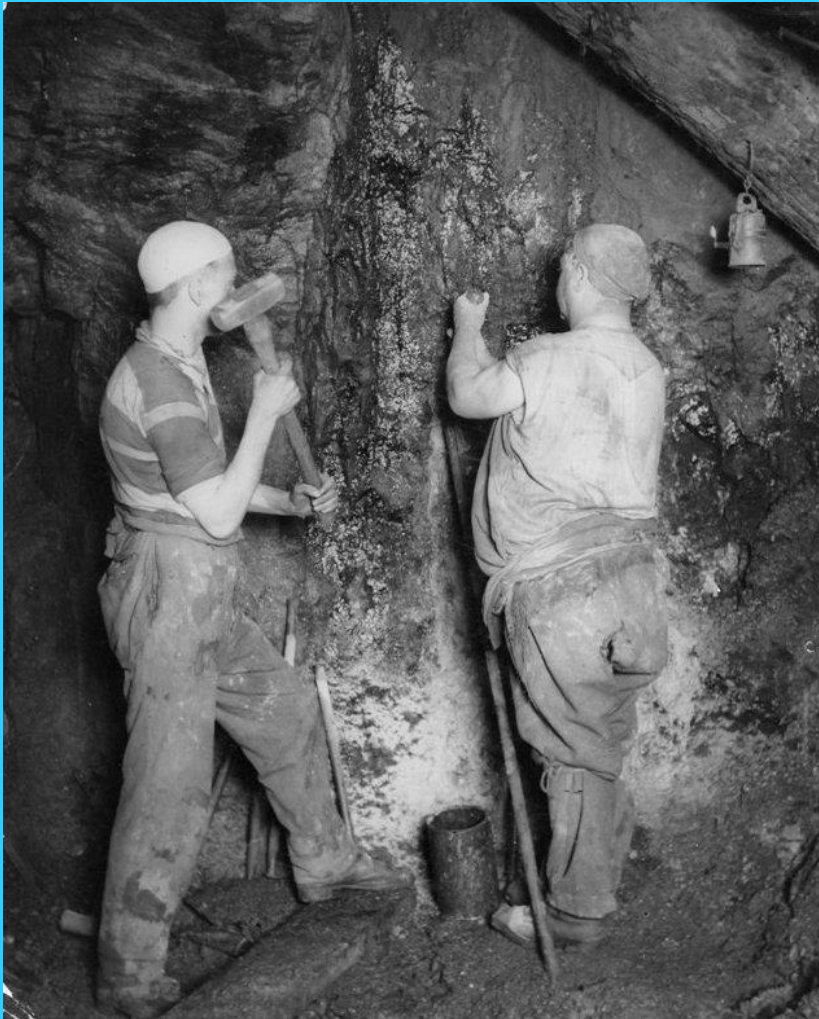


ORE HOISTED UP THE INCLINE

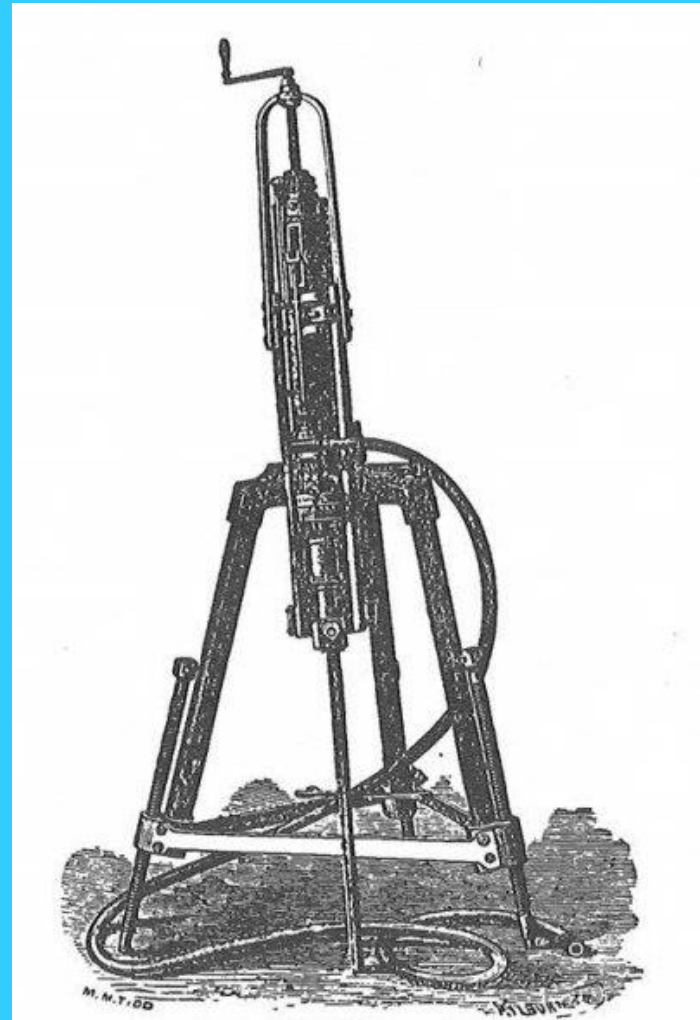


UBERROTH UNDERGROUND MINING METHODS

MINERS SINGLE JACKING

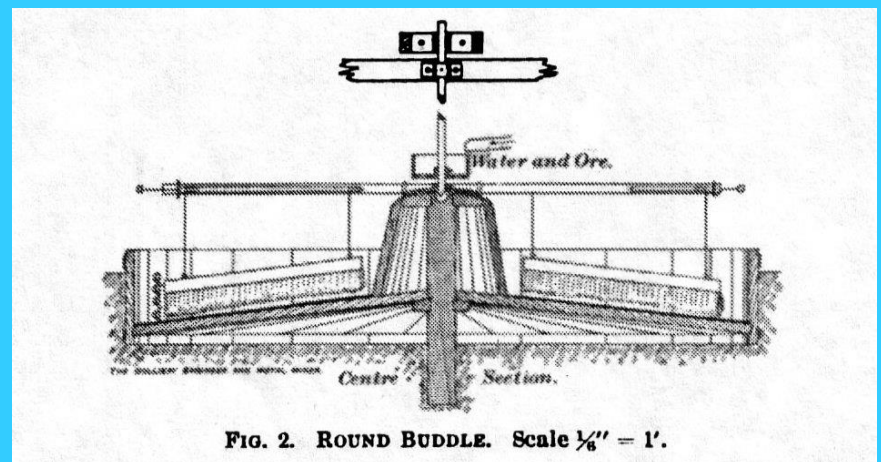
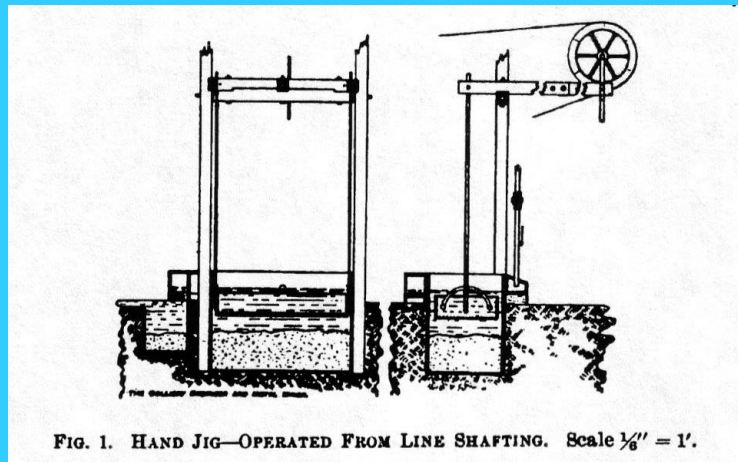
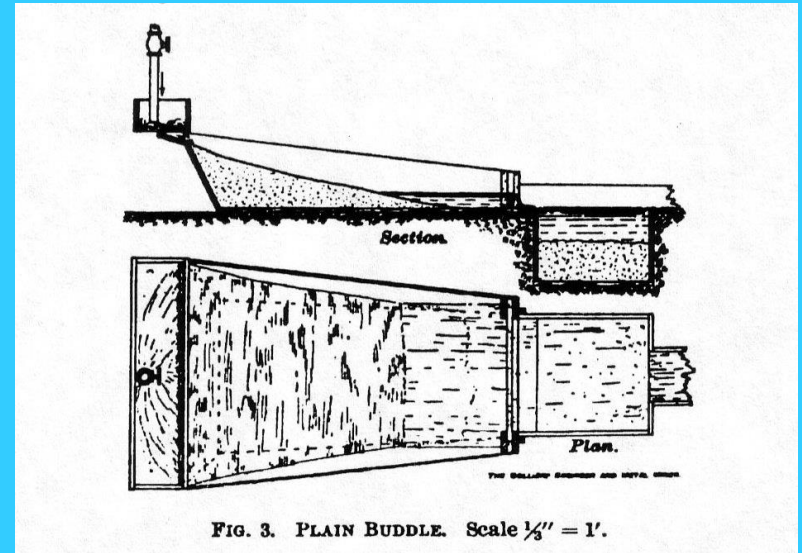
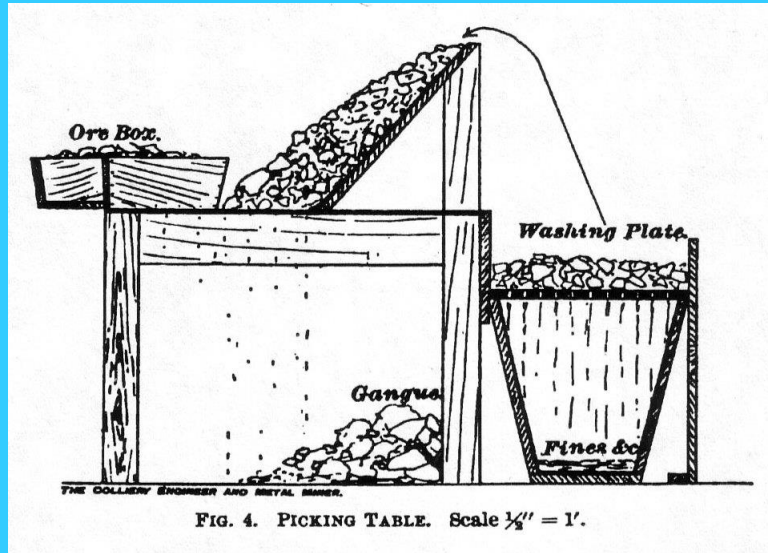


BURLEIGH COMPRESSED AIR DRILL



(Geevor Mine Museum, 2018; Raymond, 1872)

UBERROTH ORE PROCESSING METHODS



UBERROTH MINE, ca1880s

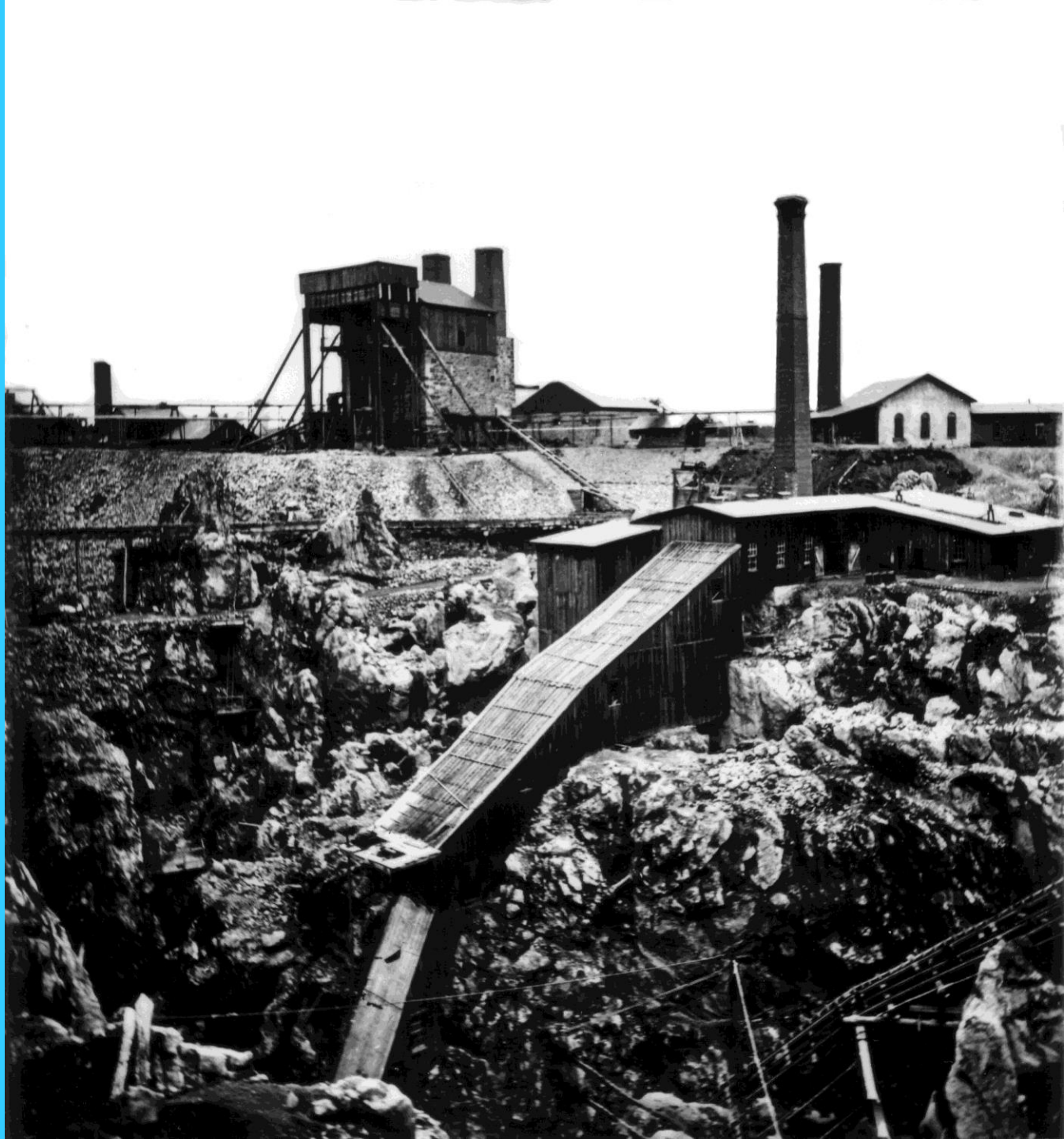
Wetherill Patents
Expire, 1876

Lehigh Zinc Closes Its
Mines, 1876

Bergen Point Zinc Co.
Owns All Mines, Forms
Friedensville Zinc Co.,
1881

Mines Close, 1893

(Miller, 1924, Plate II A)



UBERROTH MINE AFTER CLOSURE, ca1910

Alice Pascoe was the granddaughter of **Richard W. Pascoe**, Uberroth Supt.



(Left to right) Engine House, Boiler House, and Mine Office

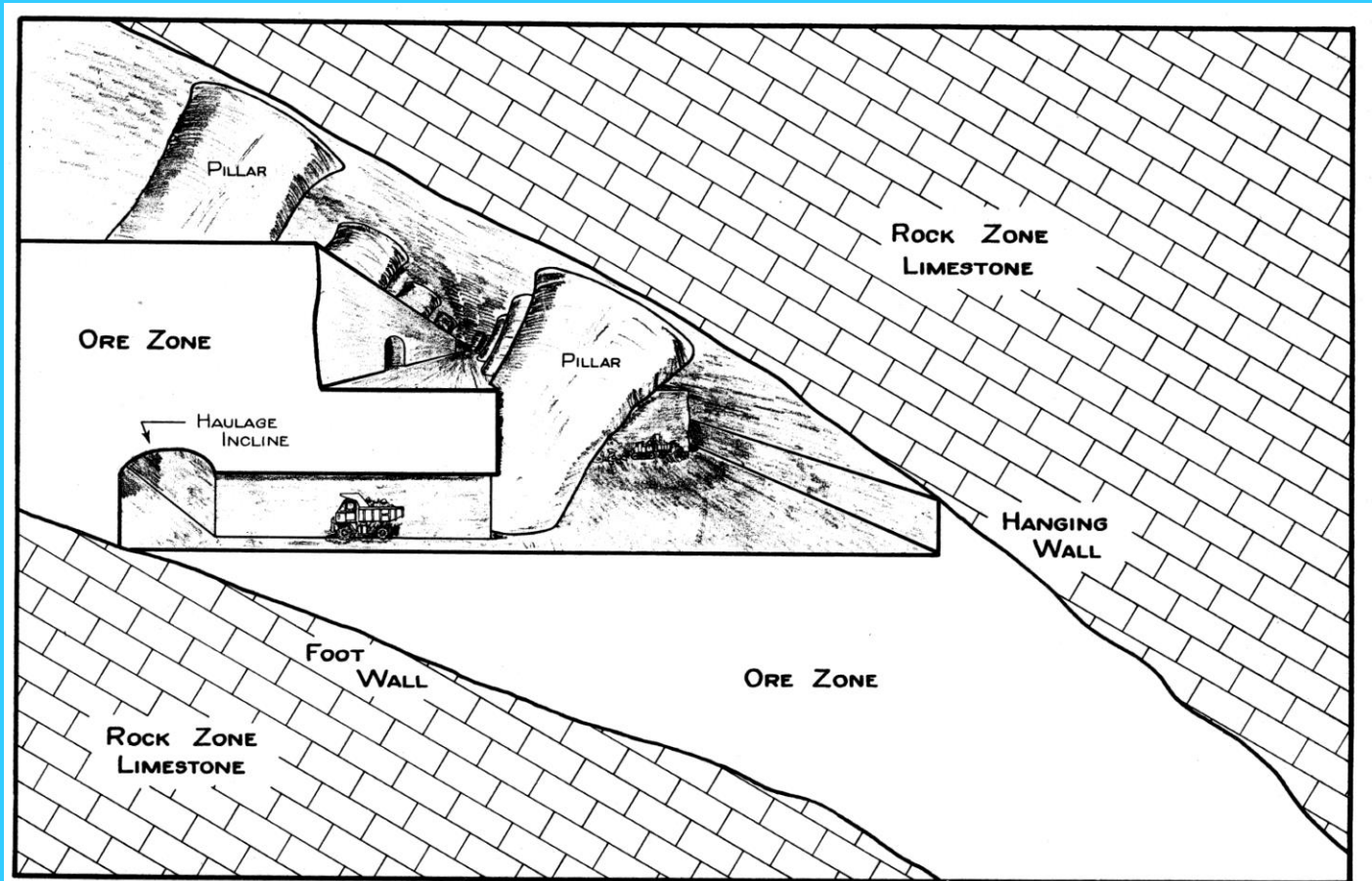
(Lehigh University, Bill Weiner Collection)

NEW HARTMAN MINE DURING NJ ZINC CO. EXPLORATION, 1916-17



(Library of Congress)

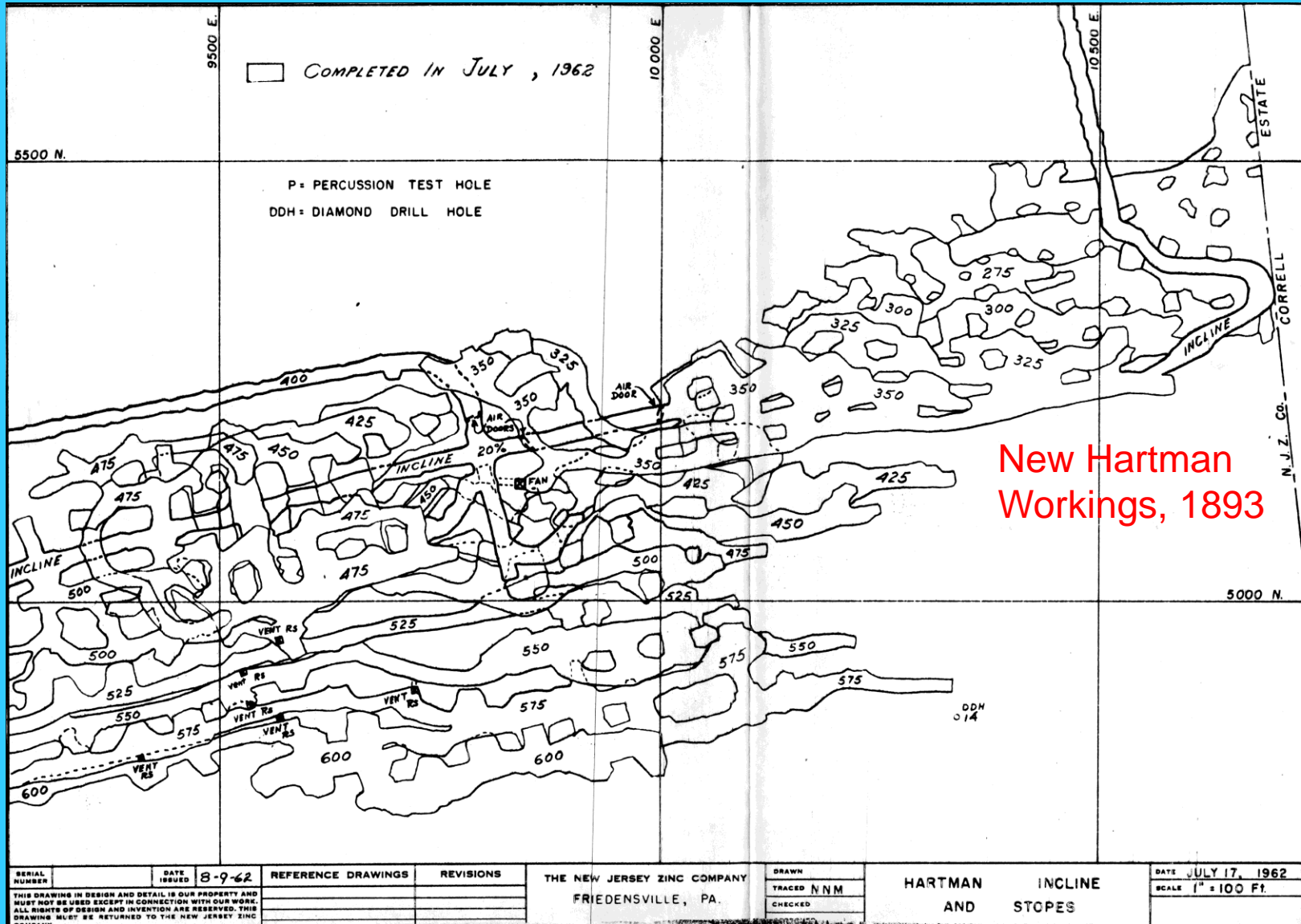
NJZ FRIEDENSVILLE MINING METHOD, 1958-1983



CROSS SECTION
SHOWING
PROPOSED MINING SYSTEM
FOR FRIEDENSVILLE
- LOOKING EASTERLY -

(New Jersey Zinc Company, 1962)

NJZ FRIEDENSVILLE MINE UPPER LEVELS, 1962



New Hartman
Workings, 1893

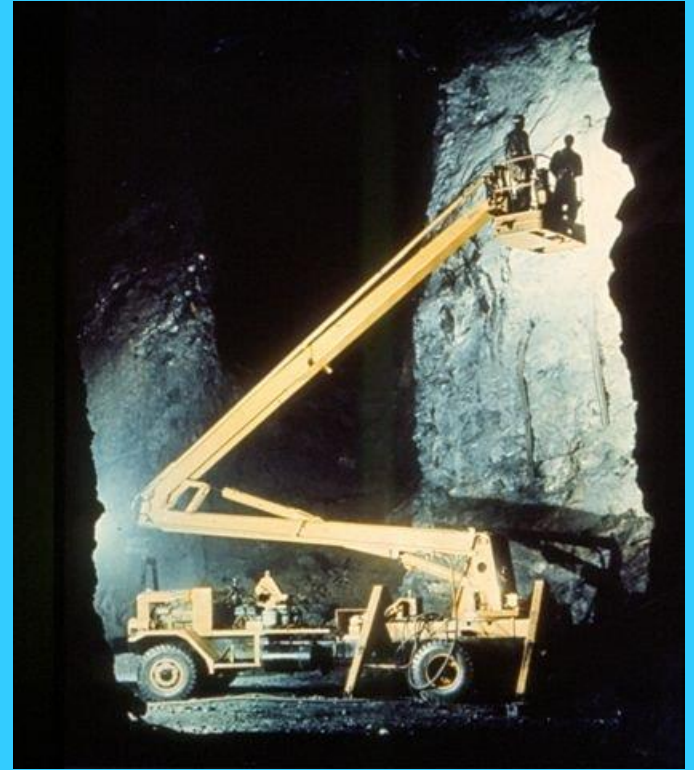
<table border="1"> <tr> <td>SERIAL NUMBER</td> <td>DATE ISSUED</td> <td>8-9-62</td> </tr> </table>	SERIAL NUMBER	DATE ISSUED	8-9-62	<table border="1"> <tr> <td>REFERENCE DRAWINGS</td> <td>REVISIONS</td> </tr> <tr> <td> </td> <td> </td> </tr> </table>	REFERENCE DRAWINGS	REVISIONS			THE NEW JERSEY ZINC COMPANY FRIEDENSVILLE, PA.	<table border="1"> <tr> <td>DRAWN</td> <td>HARTMAN</td> <td>INCLINE</td> </tr> <tr> <td>TRACED NNM</td> <td>AND</td> <td>STOSES</td> </tr> <tr> <td>CHECKED</td> <td> </td> <td> </td> </tr> </table>	DRAWN	HARTMAN	INCLINE	TRACED NNM	AND	STOSES	CHECKED			<table border="1"> <tr> <td>DATE</td> <td>JULY 17, 1962</td> </tr> <tr> <td>SCALE</td> <td>1" = 100 Ft.</td> </tr> </table>	DATE	JULY 17, 1962	SCALE	1" = 100 Ft.
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(New Jersey Zinc Company, 1962)

NJZ FRIEDENSVILLE MINE



(Clockwise) Mine and Mill, Scaling the Back from a “Giraffe,”
Underground Pump Station, Loading Ore (Photos Courtesy
Ken Cox, ca1976)



FRIEDENSVILLE MINES REDEVELOPMENT

NJZ
FRIEDENSVILLE
MINE WORKINGS
SHOWN IN RED,
1958-1981



(Google Earth Image 2013,
annotations by author)

FRIEDENSVILLE PRODUCTION ESTIMATES

1853-1893 Period (Based on Miller, 1924; Smith, 1977)

Est. Total Production (All Mines): 800,000 tons ore
Uberroth Mine 450,000 tons ore
Old Hartman Mine: 200,000 tons ore
Correll Mine: 100,000 tons ore
Three Cornered Lot Mine: 50,000 tons ore

Average Ore Grade: 30% Zinc

Hand-Picked Sphalerite Grade: 45% Zinc

1958-1983 Period (Based on Metsger, 1973; Smith, 1977)

Friedensville Mine Capacity 2000-2200 tpd ore

Friedensville Mill Capacity 2500 tpd ore

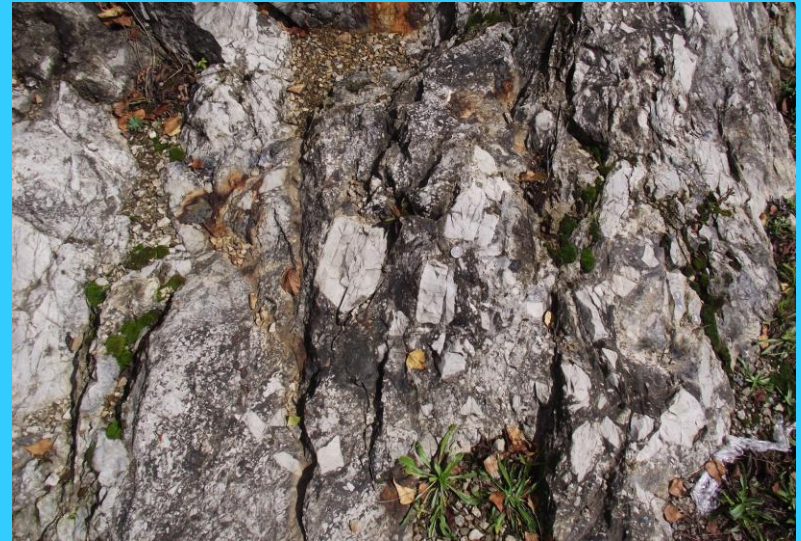
Est. Total Ore Production (25 years): 14,000,000 tons

Est. Total Zinc Production: Over 900,000 tons

Ore Grade: 5.5-6.5% Zn

TOTAL VALUE \$3.0 BILLION (Based on Zinc Price, 3 May 2018)

FRIEDENSVILLE HISTORIC MINE SITES



(Clockwise from Upper Left) Uberroth Mine with Cornish Engine House, Engine House Stonework, Breccia Exposed in Old Hartman Pit, and Old Hartman Pit (Kaas Photos, 2007 and 2012)

HISTORIC FRIEDENSVILLE VILLAGE



(Clockwise from Upper Left) Friedensville Church, ca1839; Uberroth Mine Superintendent's House, ca1840; David Hartman House, ca1870; and New Jersey Zinc Employee Housing, ca1950 (Kaas Photos, 2012)

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