Underground Limestone Mines - Case Histories of Sustainable Industrial, Research, and Commercial Use

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History of Underground Limestone Mines in the United States

- Limestone and various sulfide ores have been mined underground since the early 1800’s
Advantages of Underground Limestone Mines

→ Large space > 90,000 m²
→ Can be secured with limited access
→ Generally stable back, pillars, and floor
→ Fireproof
→ Climate controlled environment
→ Well ventilated – generally no noxious gases
Examples of Post Mining Uses of Underground Limestone Mines

- Civil defense or storm shelter
- Warehouse – storage facility (Subtropolis - Kansas City)
- Underground office complex
  - Secure data storage and recovery center
- Mushroom farming (Creekside Mushrooms – 27MM Kg/yr)
- Research facility (USBM/NIOSH)
Case Histories of Sustainable Use of Abandoned Limestone Mines

Case History No. 1

- Highbridge Springs Bottled Water and Kentucky Underground Storage
  - Active underground mining stopped by water inflow from a sinkhole
  - Two businesses developed from an abandoned underground quarry purchased at a property tax auction
Aerial View of the Facility

Abandoned Surface Quarry

Portal Entrance to KUS and HSW
History of Highbridge Springs – Kentucky Underground Storage

- Prior Uses of the Quarry
  - Civil Defense Shelter
  - Bulk Cheese Storage
  - Storage of Cars, Boats, Recreational Vehicles
Current Use of the Underground Mine

Highbridge Springs Water
- Built in the “wet” side of the quarry
- Dam constructed to impound 25MM l of water
- Initially produced distilled water
- Developed reverse osmosis bottled water plant

Kentucky Underground Storage
- Storage of cars, boats, RVs
- Developed climate controlled section for record storage
- Storage of business, government, Univ. of KY rare book collection
Underground Data Storage – Data Recovery Centers

- Abandoned limestone mines are well suited to data storage – data recovery
- Highest and best use of an abandoned mine
- Transition from bulk storage to sophisticated data storage and recovery
- Clients include:
  - Government
  - Banks, Brokerage house, Financial institutions
  - Hospitals
  - Multi-national corporations
  - IT corporations
Data Storage – Data Recovery Centers

Completely, Self-Sufficient, Autonomous Underground Operation

- Large space 7.6m-8.5m high, +/- 93K m²
- Stable back, pillars, and floor
- Limited and secure access, available 24hrs.
- Minimal surface exposure/visibility
- Unaffected by weather
- Redundant power supply
- Some close to metropolitan cities/transportation
Underground Data Storage – Data Recovery Centers

• Case History – Iron Mountain
  – Located in a mine north of Pittsburgh, Pa.
  – Currently housing paper records and tape in a 158K m²
  – Mine has transformed into a data storage and recovery center with an underground community of 2,700 employees
    • Redundant power
    • Fire department
    • Potable water from mine pool & treatment plant
    • Ventilation to cool servers and electronics

• Goal is to create multiple centers funded as a real estate investment trust (REIT)
U.S. Bureau of Mines created an experimental mine in 1911 to conduct field scale experiments. Objective was to determine the role of coal dust in mine explosions. CH₄ thought to be the sole source of mine explosions.

Abandoned Pittsburgh seam mine in Bruceton, Pa. selected as it is on the USBM campus.

Not popular with surrounding commercial and residential area.
In 1979 USBM identified an abandoned limestone mine on a 162-ha tract in rural West Virginia.

- Existing mine abandoned due to sinkhole and roof conditions in isolated section
- USBM desired a field laboratory for mine explosion and mine fire research
- USBM desired an underground laboratory where geometry of longwall and room-and-pillar mines would be duplicated
USBM Lake Lynn Laboratory

- New area of the LLEM driven to NE of existing mine workings
- Existing mine workings provide a “muffler zone” where the vibration, air-blast, dust, and smoke associated with an explosion is dissipated.
- Non flammable mine
- No substitute for full scale testing of explosions and fires
By 1982 the laboratory was completed

- 40,250km of data & video cables embedded in the walls
- Full scale CH₄ and dust explosion
- In 2006 full scale mine seal testing done in response to Sago accident
- Bulkhead testing in isolated heading that was pressurized with water
Case History - Conclusions

- An abandoned limestone mine can be used for multiple applications
  - Warehousing, truck depot, and bulk storage
  - Highly secure document and data storage
  - Data recovery centers developed for multiple clients
  - Mushroom farming
  - Bottled water or manufacturing plants

- Once ground conditions are stabilized
  - Low maintenance costs
  - Secure, climate controlled environment
Underground Limestone Mines

Have the Potential to be More Valuable in a Post Mining Use
Than During Mining