Emerging risks due to extreme storage of hazardous materials

Pablo Lerena
Institute of Safety and Security SWISSI

Ulrich Krause
BAM Federal Institute for Materials Research and Testing

Presenting the iNTeg-Risk project
1st iNTeg-Risk conference
June 2-3, 2009, Stuttgart

basic description:

- What are the new challenges in storage processes?
- What are the emerging risks?
- What are the risk assessment procedures now?
- What will be new in risk assessment and safety solutions?

What are the new challenges in storage processes?

- Distributed storage of „new“ energy carriers (H_2, LNG)
- Storage of large masses of CO_2
- New storage technologies for fossile fuels (e.g. > 10^5 t of coal)
- Underground storage of potentially chemically active materials
- Underground storage of radioactive materials
- Above-ground storage of chemically active wastes and recycling materials

New storage technologies for fossile fuels

above-ground silo coal storage at a power plant (2 x 50.000 t)
(from www.eurosilo.com)

underground coal storage at a power plant
(from www.eurosilo.com)

Underground storage of potentially chemically active materials

Emerging risks consideration: technical issues

- Failure of equipment for storage, shipping or conveying liquid and pressurized H2,
- What is the "acceptable" maximum size for storage containers for H2?
- Large coal storage: autoignition of densely packed coal, insufficient preventive methods or effective fire
- prevention that renders coal storage unusable (such as clogging to prevent transport).
- Interaction of long-term thermal and chemical stability of wastes with rock layer mechanical stability,
- Hazards of unintentional CO_2 release from containers for intermediate storage and transportation (will be addressed by Pertti Auerkari et. al.)

Emerging risks consideration: human / organisational / management issues

- Methodologies for lessons-learning from accidents, evacuation
- management respecting human behaviour in deep and complex underground infrastructures
- Large underground coal storage: HSE risk to personnel and emissions; in addition, the risk of lost district
- heating capacity that can be critical under mid-winter cold spells (clogged transport is enough to disrupt coal feed),
- …..

Emerging risks consideration: Communication / risk governance issues

- Acceptance of hydrogen applications (problem of oxyhydrogen),
- Risk mitigation of fires, explosions and toxic gases in the surrounding of large storage facilities by constructional, organisational and communicational means
- …..

The innovative solutions consist of

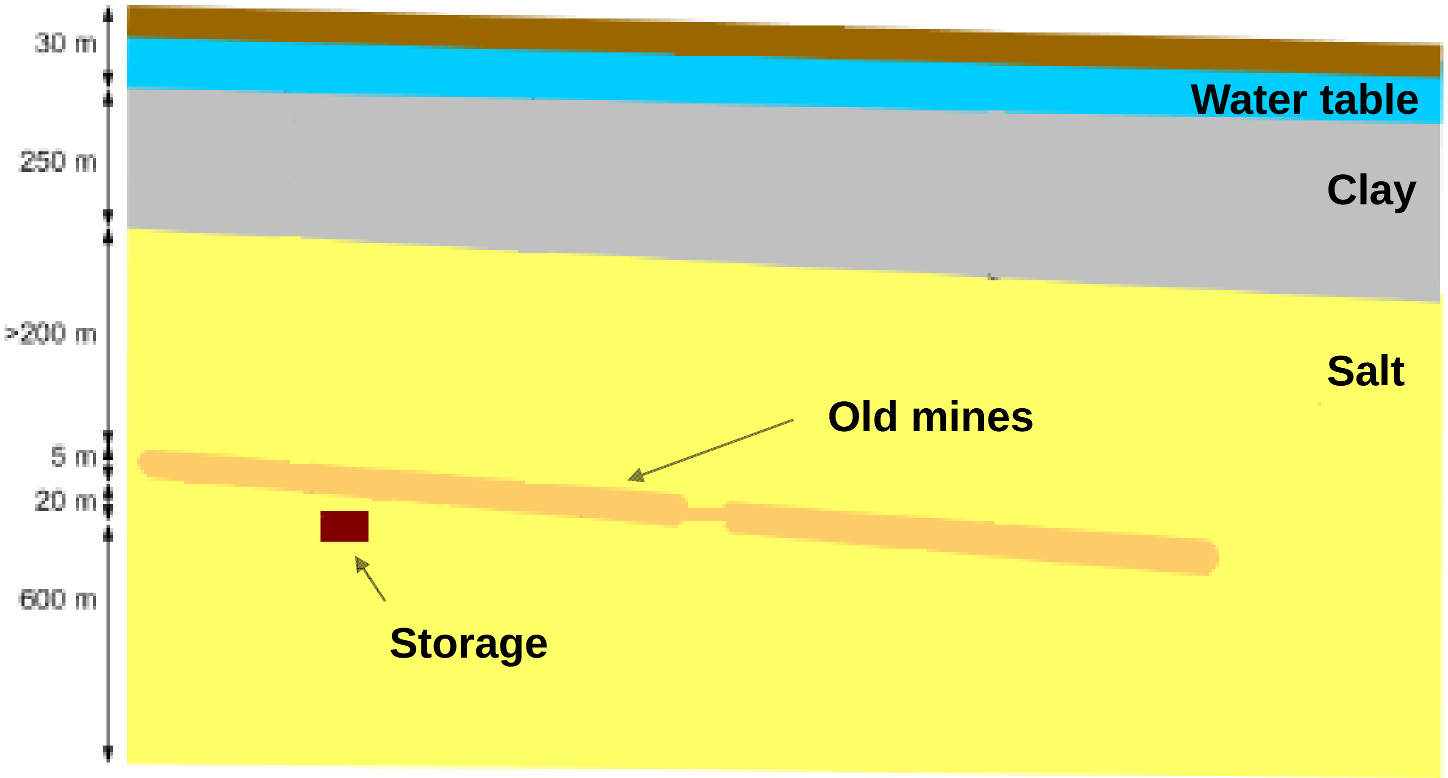
- the identification and evaluation of emerging risks for large-scale storage of liquid H_2,
- the identification and evaluation of emerging risks of large-scale storage of CO_2 (will be addressed by Pertti Auerkari et. al.),
- the application of new mathematical models for physical and chemical processes in the deposits,
- development of a new quick test for thermal stability of waste,
- development of a classification system of waste according to hazard indicators,
- application of QRA,
- application of technical barriers to dense coal ignition,

- Based on
  - “Stocamine” rapport d’expertise pour la Commission Locale d’Information et surveillance (C.L.I.S) du centre de Stockage de Déchets Ultimes Stocamine à Wittelsheim (France) (2003)
    - Alain Cantineau
    - Alain Kiennemann
    - Pablo Lerena
    - Alain Lugnier

Outline

- Description of the incident
- Hypothesis of the origin of the fire
- Consequences of the incident
- Lessons learnt

Stocamine: underground storage of waste



Source of the picture: BMG Engineering, Schlieren- Zürich

Picture from a similar storage (Nerfa- Neurode in Germany)

Source of the picture: BMG Engineering, Schlieren- Zürich

Fire

- September 10th, 2002
  - Fumes and smell
- Aeration of the sector is reduced, fire fighting with water
  - Fumes are reduced but not eliminated
  - CO, CO_2, SO_2… monitoring:
    - Despite two attempts of reducing oxygen still signs of combustion

Fire

- Final attempt on extinguishing the fire
  - Infrared detection of the hot spots
  - Extinction with water
- November 17th, 2002
  - The fire is extinguished

Origin of the fire (hypothesis)

- At the beginning of September:
  - Storage of “big-bags”: asbestos- containing residues of a fire
    - Foul odour, liquid drain
- Self-heating of these products
  - Self-sustained combustion also in reduced oxygen atmosphere
    - Presence of oxidizing substances (fertilizers)

Consequences of the fire

- Exposure of the operators
  - Operators tried first to extinguish the fire without protection
    - As the stored products were supposed not being combustible, no procedure was in place to intervene in case of a fire producing toxic fumes
  - Contamination with dioxin of some galleries
    - Potential exposure during future work in the storage

Consequences of the fire

- The activity of the storage was stopped
- The sector were the fire occurred was closed
- What to do with the 44000 t of waste present in the mine?
  - Stay forever (closing the shafts)
    - Pollution in 500, 1000 years?
  - Take them out
    - High occupational risks (asbestos)

Lessons learnt

- The risks related to the thermal instability and combustibility were known but forgotten
  - The fact that asbestos-containing waste may contain combustible or self-heating materials went unnoticed
  - Testing for content of asbestos-containing waste is difficult
- Improved preventive procedures to avoid storing combustible and self-heating materials
- Define emergency procedures to intervene if however a fire occurs

Thanks for your attention !