



# Mine Rescue Challenges in Deep Ontario Mining Operations

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# Objectives

- Deep Mining
- Hot Environments
  - Heat Stress Research
- Underground fires
  - Underground Refuge Stations
- Mine Rescue Challenges during Shaft Sinking
- Rock Bursts Seismic Activity and Emergency Response \*





# What is considered to be deep mining?

- Typically 3000 feet or more is considered deep by Canadian terms.
- Canada is one of the few countries besides South Africa with many deep mines. \*





# South African Mines

- TauTona 3.9 Kilometers.
- Savuka Mine 3.8 Kms.
- East Rand Mine 3.6 Kms. \*





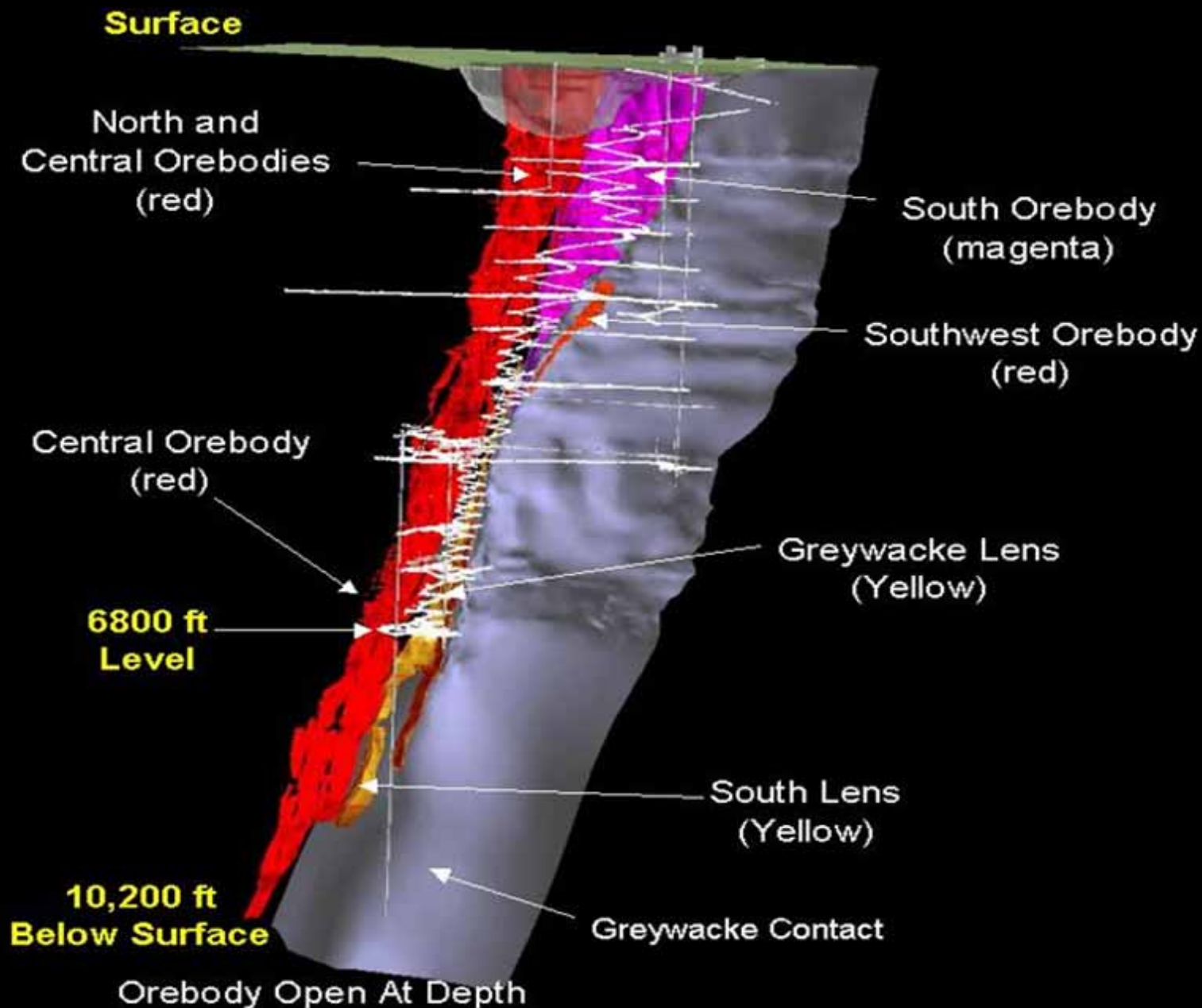
# Canadian Mines

Xstrata Copper	9750 feet	2.97 Km
Vale - Creighton Mine	7800 feet	2.38 Km
Goldcorp Red Lake Mine	7150 feet	2.18Km
Kirkland Lake Gold Mine	7100 feet	2.16 Km
Red Lake Mine	6300 feet	1.92 Km
LaRonde	2.9 Km	(3.1 Km)*



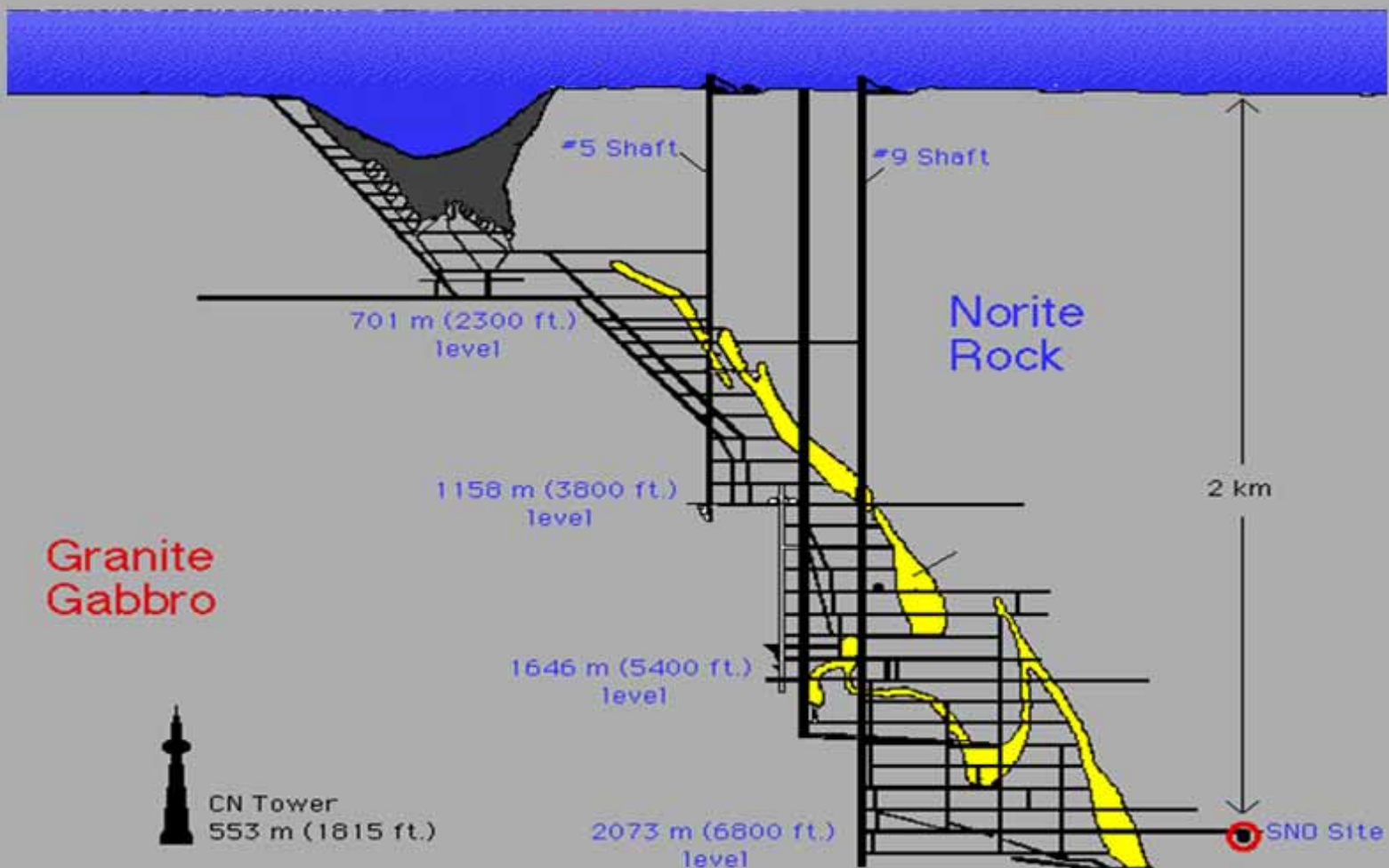


# Kidd Creek Mine Section



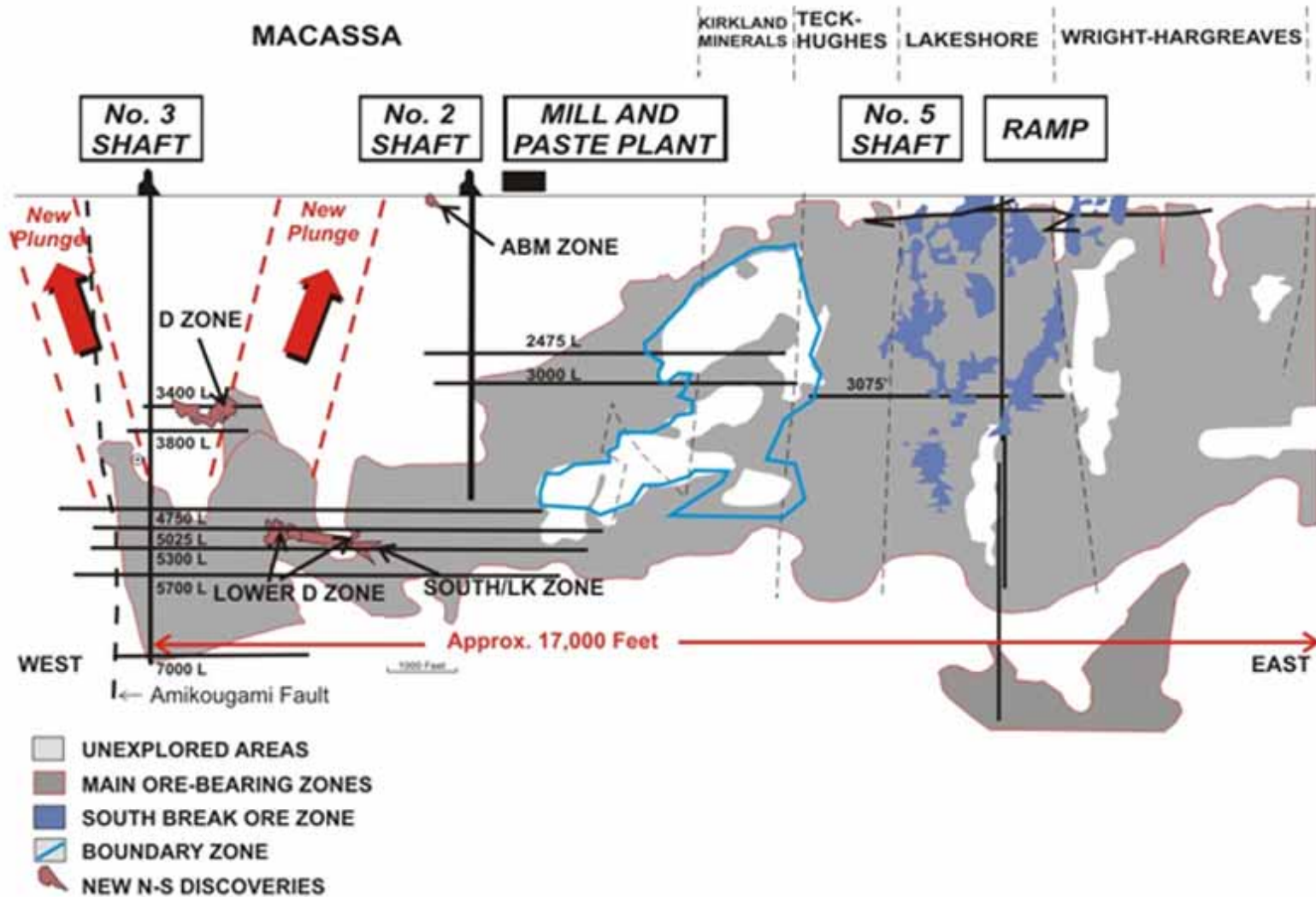


# Creighton Mine Section





# Macassa Mine Section





# Rock Temperatures

- Rock temperatures Precambrian shield mines approximately 55 Celsius (131 Fahrenheit) at 10,000 feet.
- Rock temperature at:
  - Creighton mine at 2.4 Km is 48 Celsius
  - Xstrata Copper at 3.0 Km is 35C
  - Onaping Depth at 2.4 Km is 45 C
- Mine rescue teams responding to emergencies can be subjected to heat induced injuries if precautions are not taken. \*





# Challenges Associated with Deep Mining

- Distances (Both Vertical and Horizontal).
- Availability of air and water.
- Heat and Humidity.
- Rescue during shaft sinking. \*





# Research in Hot underground Environments

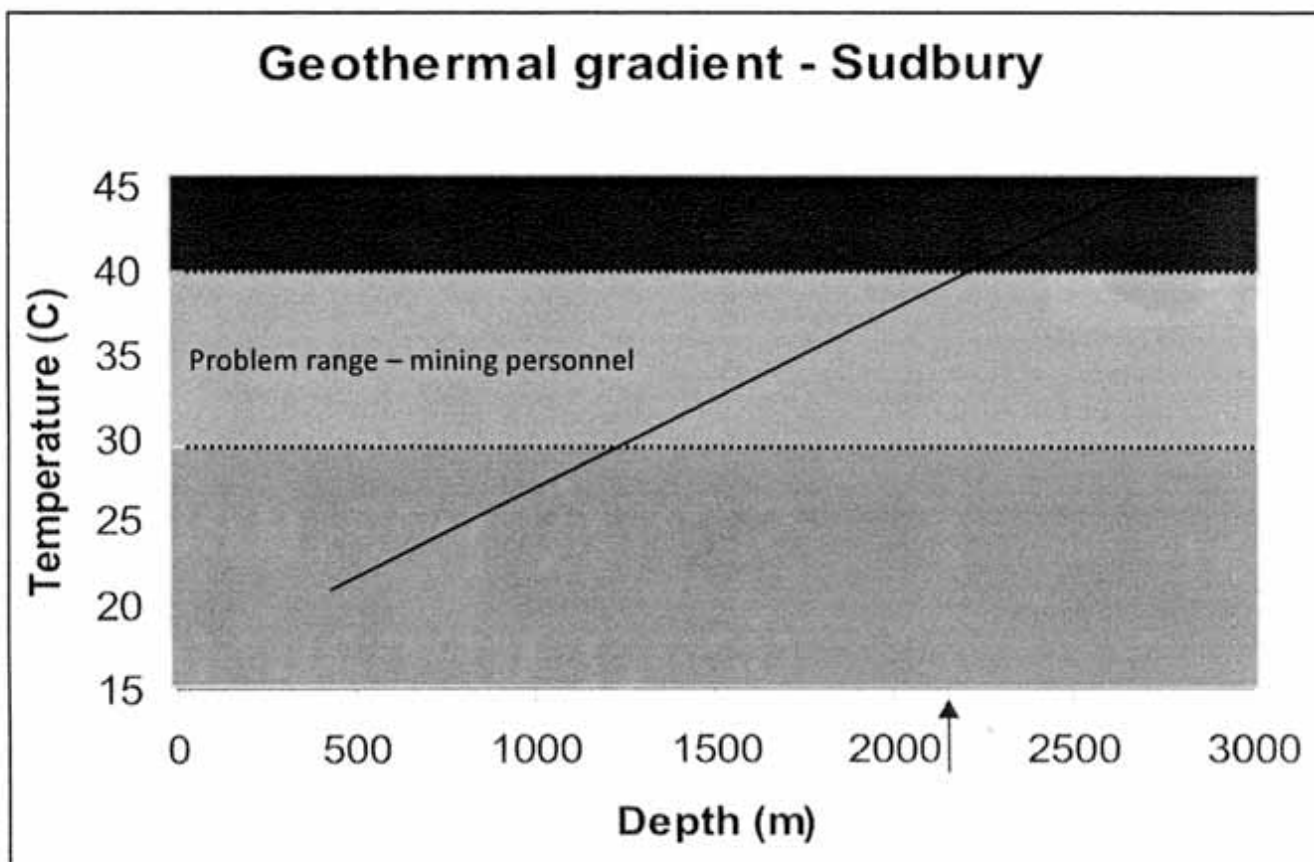




# Heat Stress Reserach

- A risk associated with working at depth is the possibility of heat related disorders such as heat stress. In deep mines, workers can be exposed to very high ambient air temperatures as a result of high rock temperatures, auto-compression of the ventilation air and heat generated by the mining machinery.
- This project is currently evaluating common mining tasks and working conditions. A review of existing and potential heat exposure guidelines and regulations will follow to determine which provides proper worker protection. In addition, the effects of worker acclimatization, the need for work/rest regimens, instrumentation/monitoring requirements and worker education will be investigated. \*





**Figure 1.** Ambient air temperature as a function of mine depth.

*Source: Natural Resources Canada, Sept. 2005*



# Mine Rescue Simulation – An Assessment of A High Intensity Task and Its Potential to induce Heat Exhaustion



Natural Resources  
Canada

Ressources naturelles  
Canada





# Scope of Heat Stress Research

- Time and Motion Studies (Agnico Eagle LaRonde Mine).
- Task Intensity Breakdown.
- Mine Rescue work deemed to be one of the most demanding tasks in Ontario mining today.
- Ottawa University research paper, "Assessing the Work Intensity of Mine Rescue Activities and its Relevance in Applying Heat Stress Management Protocols". \*





# Energy Analysis Apparatus Configuration





# Research

## University of Ottawa

Calorimeter studies  
used to establish heat  
dissipation in a  
controlled  
environment. \*



uOttawa

L'Université canadienne  
Canada's university



# MINE RESCUE GROUP

- Testing carried out over three days at the Garson Mine (Ramp Accessed Mine) – Sudbury, Canada.
- Area of testing between 440 and 660 meter levels.
- Ambient conditions ranged from 15.2 to 18.1 C and 73.7 and 96.7 %RH.
- 10 Mine Rescue volunteers working in teams of 5 man teams repeated a defined exercise lasting on average 66 minutes. \*





# Mine Rescue Task

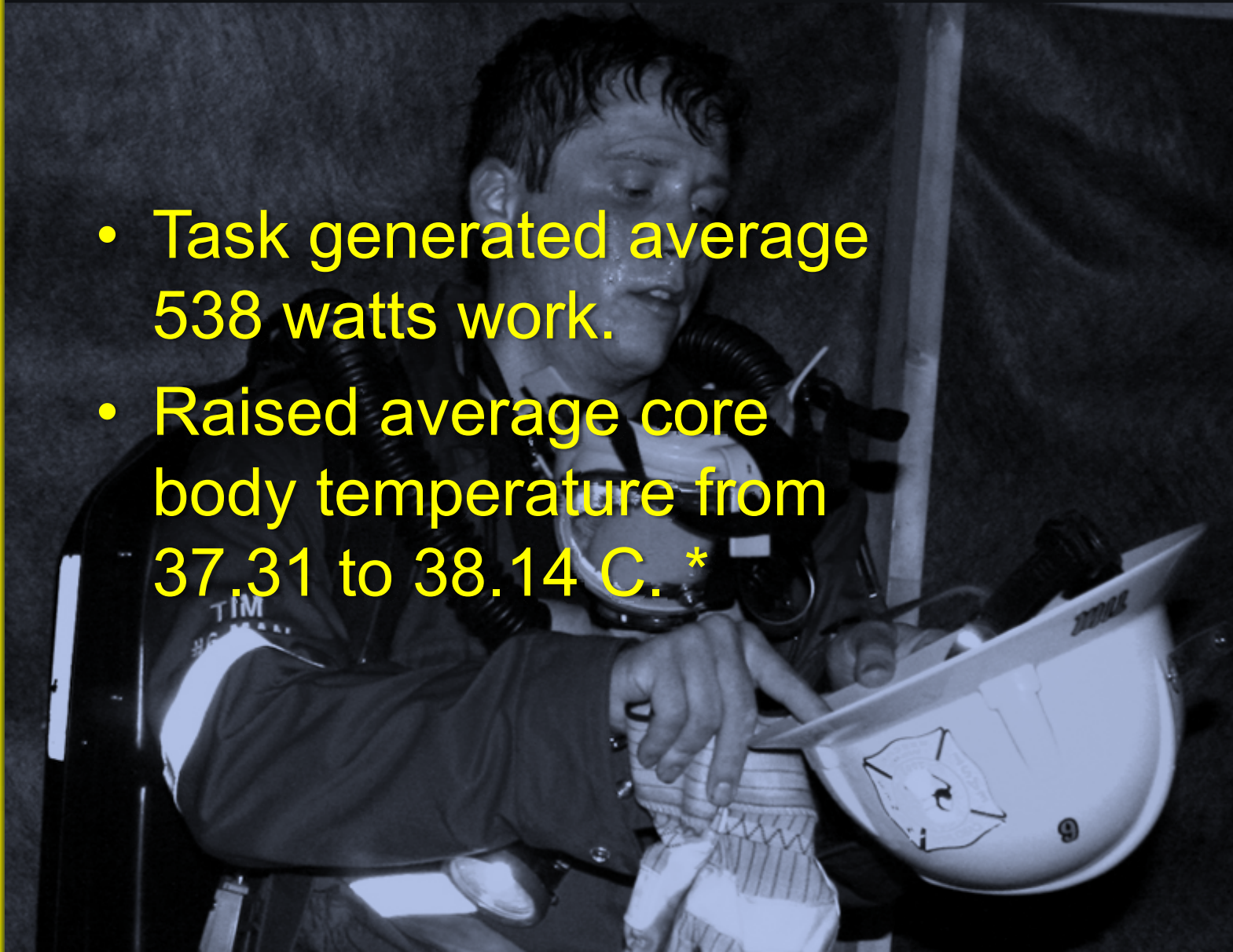
- Established a standardized exercise for teams to perform over 5 days.
- Tasks included:
  - Loading basket with tools and equipment and walk up a ramp.
  - Install pipe on drift wall.
  - Load basket 120 kgs and walk up ramp.
  - Task timeline averaged 66 minutes. \*





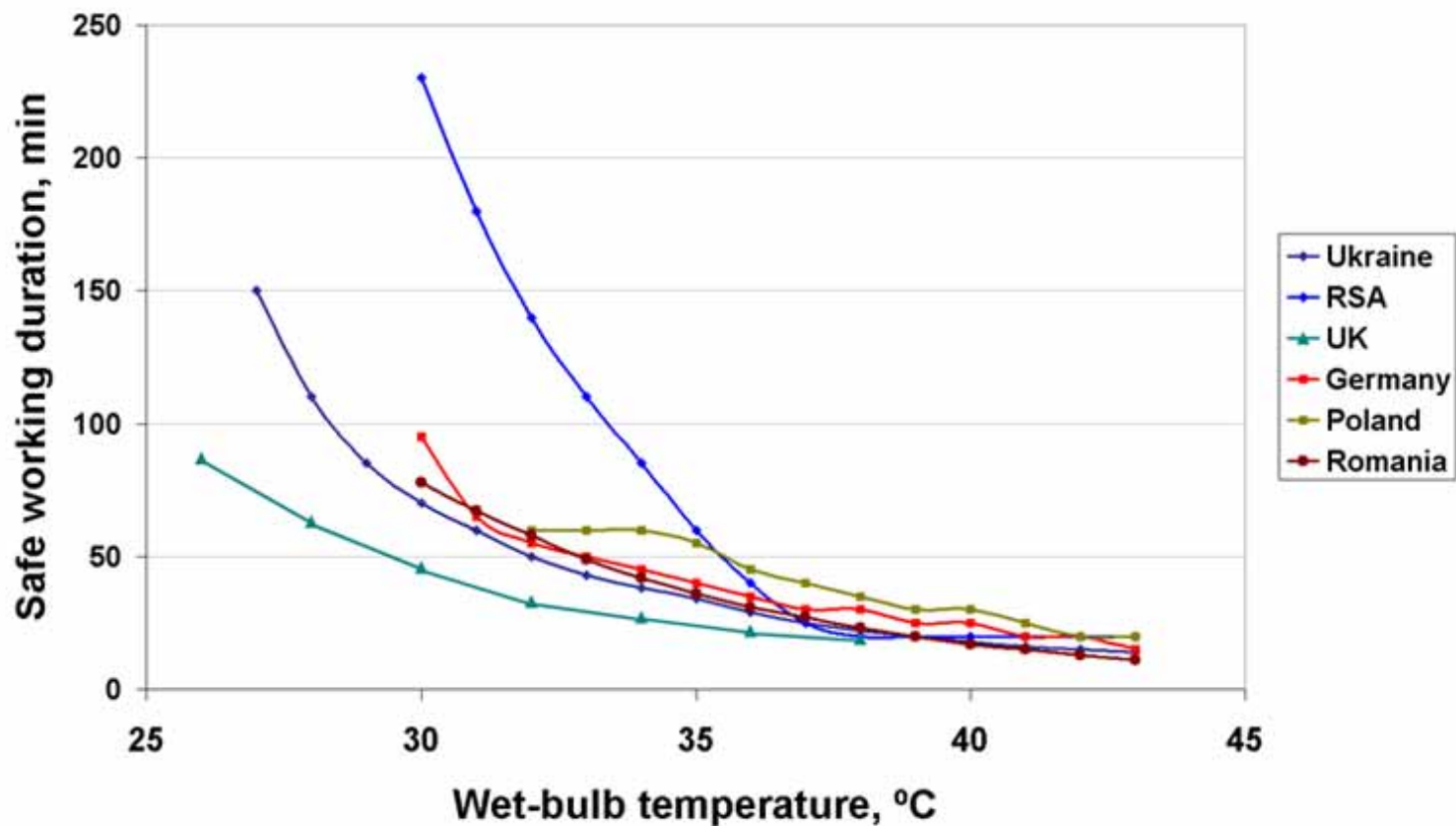
# Outcome

- Task generated average 538 watts work.
- Raised average core body temperature from 37.31 to 38.14 C. \*





## Comparison of National Rescue Heat Codes





# The importance of Hydration

*Drager's FPF 7000 hydration facemask,  
with two-litre CamelBak. \**





# Underground Mine Fires

- Ability to effective response depends on vertical and horizontal distances.
- Limits of primary breathing apparatus.
- Possibility of establishing advanced fresh air bases.
- Strategic location of comfortable refuge stations.
- Availability of air and water in far reaches of some mines.\*





# 40 Ton Truck Tire Fire





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# Compressed Air Foam Systems (CAFS)





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# Compressed Air Foam Systems (CAFS)

- Benefits:
  - Self-Contained System
  - Portable
    - Attack fires in areas without having access to compressed air and water
  - Effective
    - Smothering effect on fire
  - Efficient
    - Extremely fast fire knockdown \*





# Idealized Schematic Double Door Refuge Station





# Modern Refuge station





# Modern Refuge Station





# Shaft Sinking Challenges



Photo from Northern Business Life





# Types of Shaft Related Emergency Responses

- Fires
- Entrapment caused Rock Bursts/Falls of Ground.
- Falls from heights
- Non-routine tasks resulting in injury \*





# Challenges

- Limited access due to size of travel conveyances sinking buckets.
- Single egress limits emergency plan.
- Dangers associated with falling objects. \*





# Solutions

- Prevention is the top priority.
- Risk assessment and establishment of a mitigation plan essential components of emergency response plan.
- Maintain a pool of trained mine rescue guides who are familiar with the site.
- Conducting periodic drills and assessment of their effectiveness. \*



# Rock Burst





# Damage after Typical Rock burst





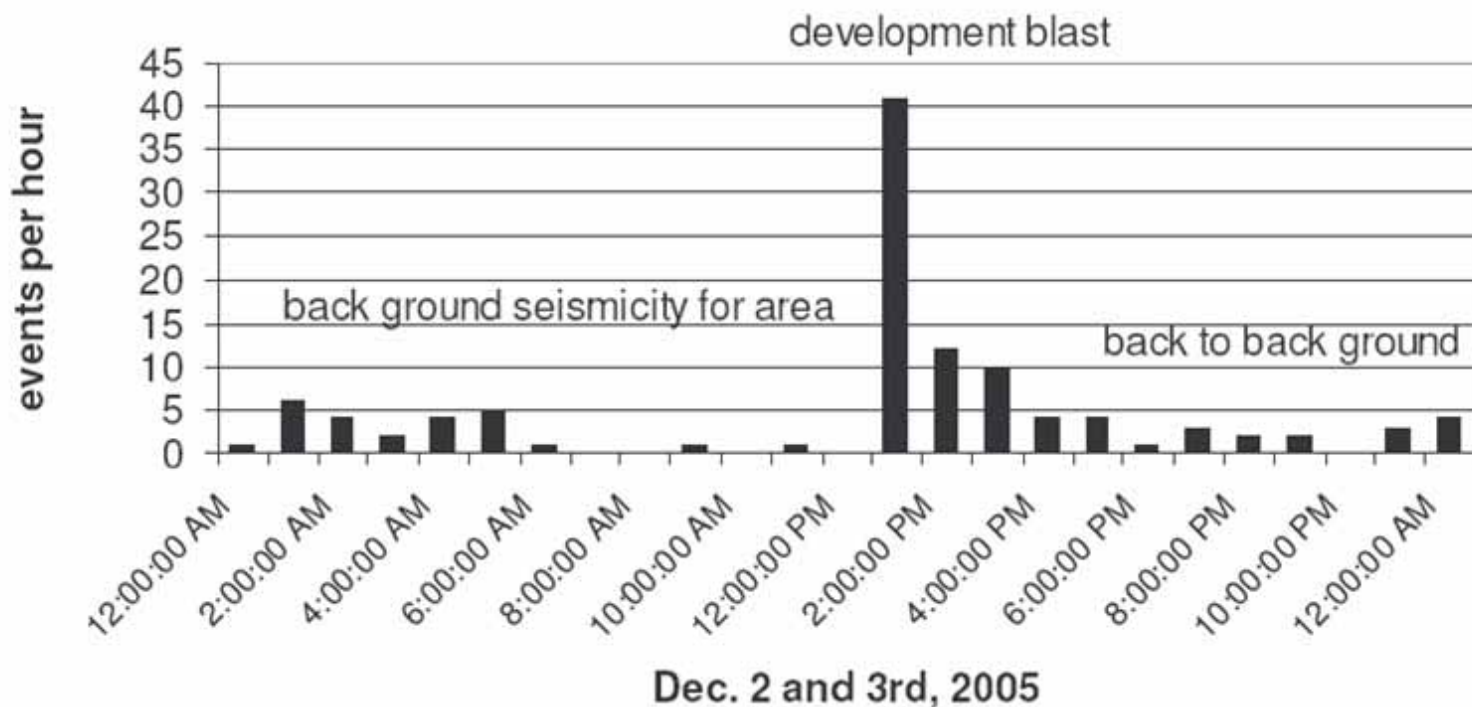
# 2006 - 2007 Ground Control Research Summary

- **Sensitive Seismogenic Zones**
- **Re-entry related to blasting practice**
- **Re-entry Time Periods**
- **Exclusion Zone**
- **Minimum Background Time Window**
- **Recommended Monitoring Parameters**
- **Re-entry Inspections**
- **Re-entry Procedures After Blasts or Large Seismic Events \***





# When is it safe to enter?





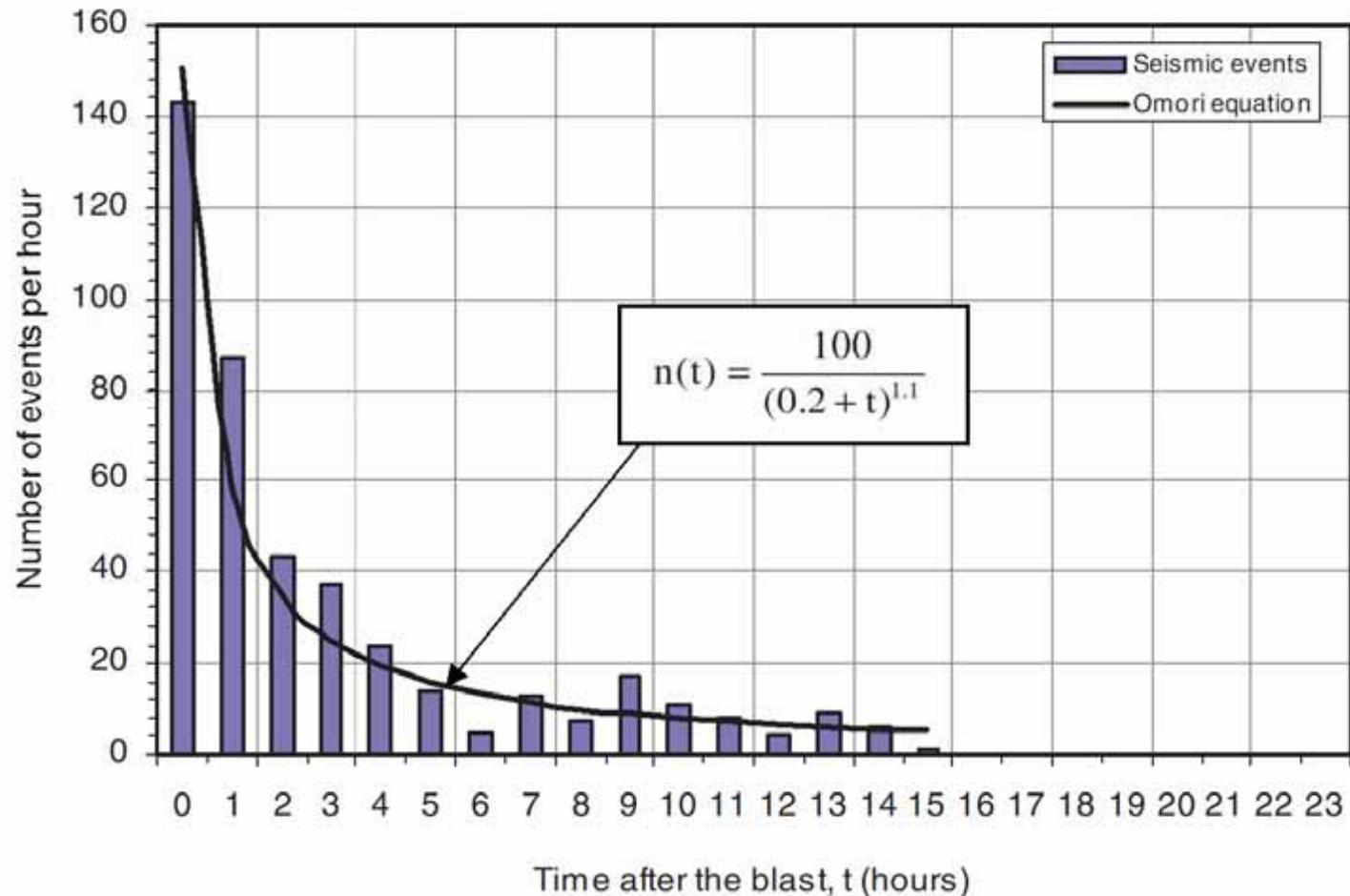
# Emergency Response Considerations

- Rescue versus recovery.
- Potential of exposing rescuers at serious risk particularly during rescue.
- Recognize/Assess/Control.
- Checking walls and back as teams advance:
  - Visual Examination – Looking for Cracks, unsupported ground
  - Sounding back with scaling bar.
  - Listening for ground movement \*





# Example showing number of seismic events after a Blast





# Summary

- Additional targeted research is required (heat stress, ground control, safety of teams etc.).
- Need for continuous improvement:
  - Integration of research findings.
- Continue working with manufacturers, educational institutions and other jurisdictions is vital to our success.
- Safety of team members will always be our top priority. \*



Thank you and "Zdař bůh"

