

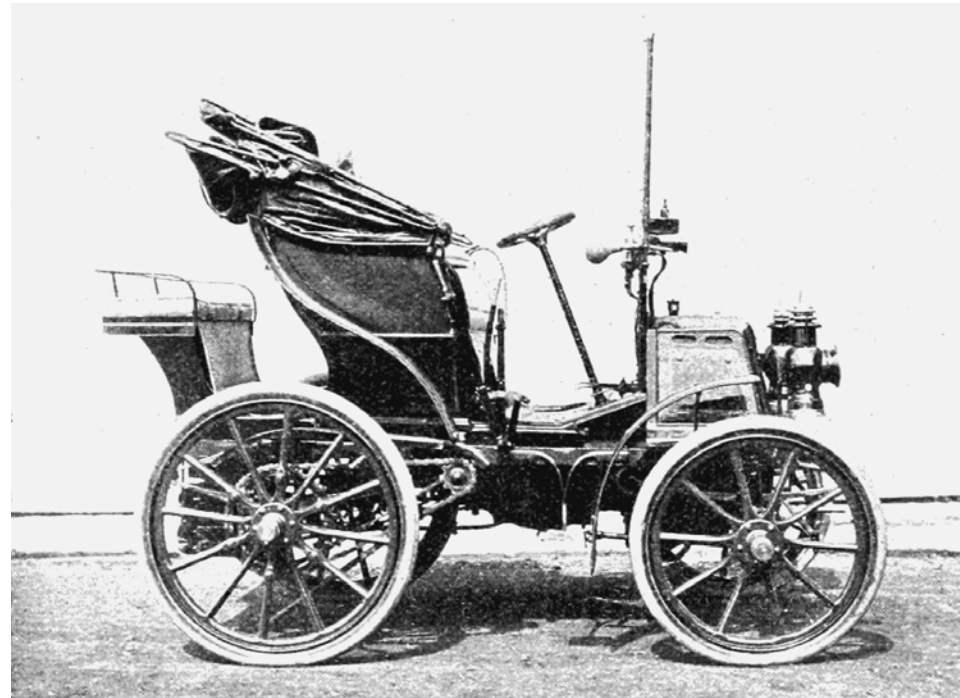


# Future Mining



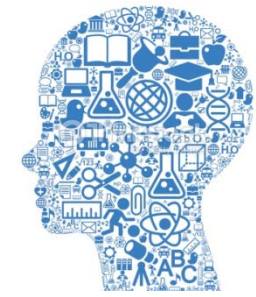


## Future Mining – Mining 4.0





## Future Mining – Mining 4.0



**Mercedes Benz 1930**



**Mercedes Benz heute**

## Future Mining – Mining 4.0

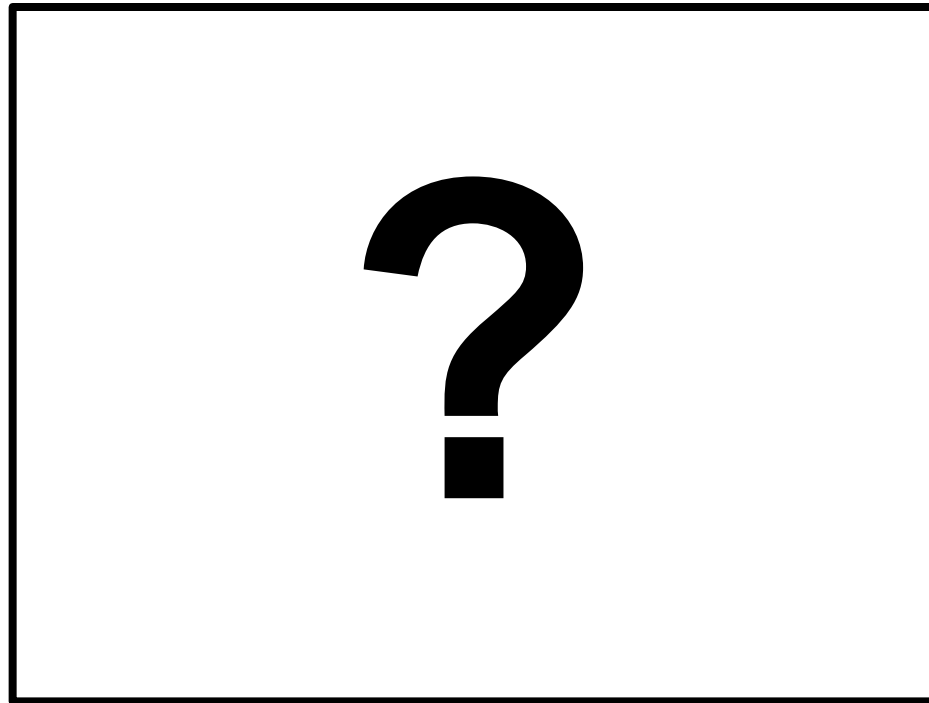


## Future Automotive

# Future Mining – Mining 4.0



**Bohrwagen – Hazemag**



**Future Boomer**



TU Clausthal

## Future Mining – Mining 4.0

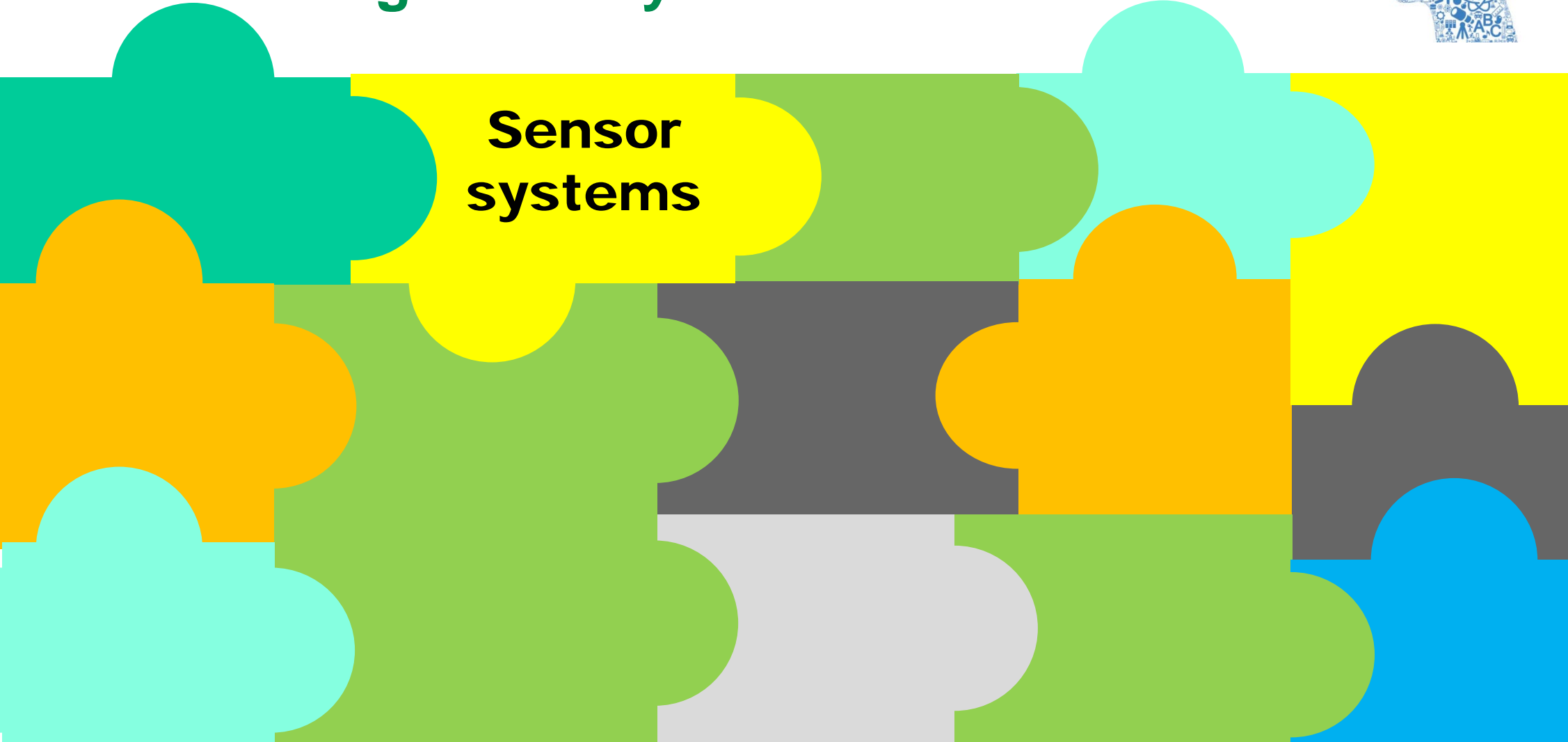


# *Automation*





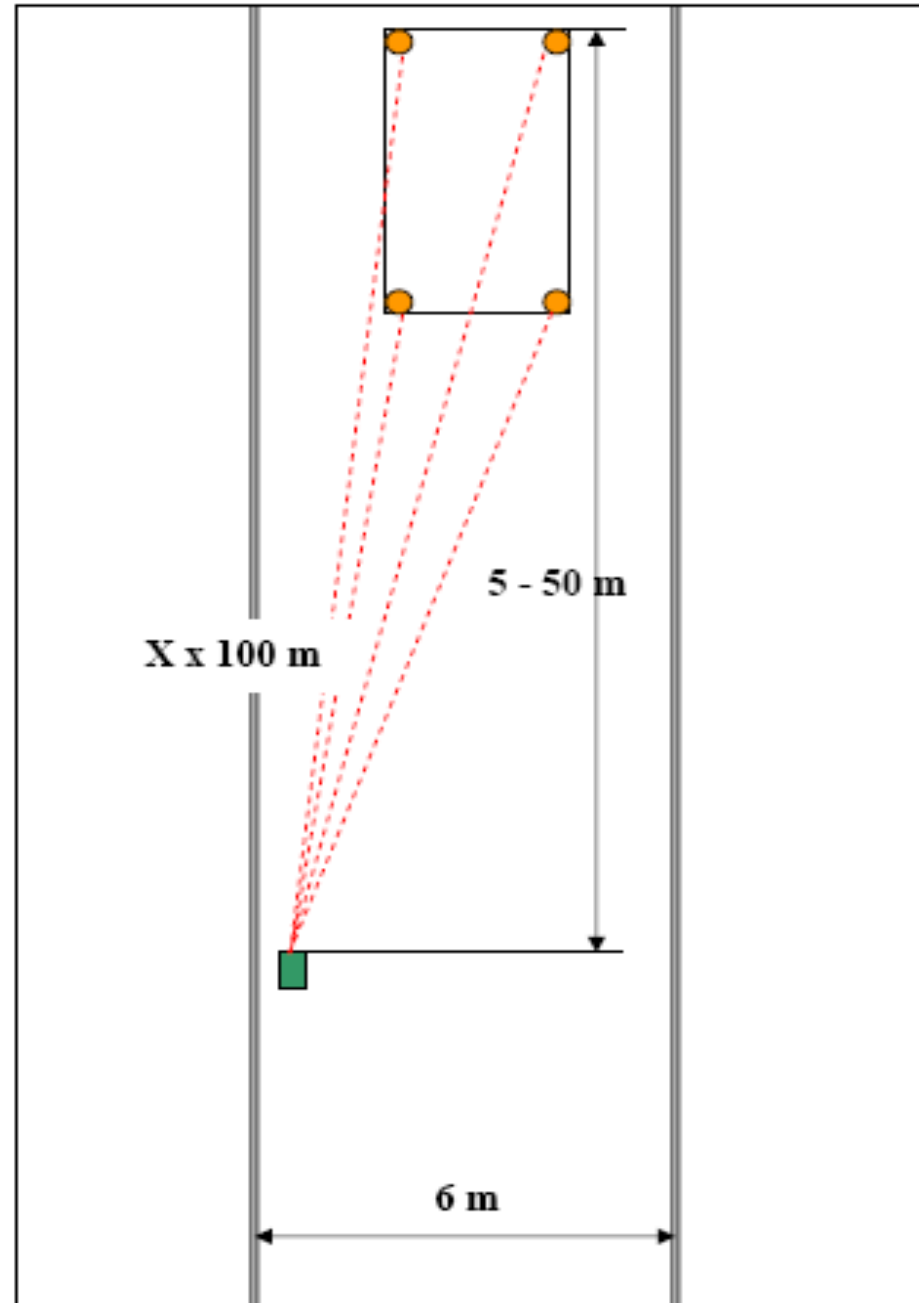
## Future Mining – Variety of influences



Sensor  
systems

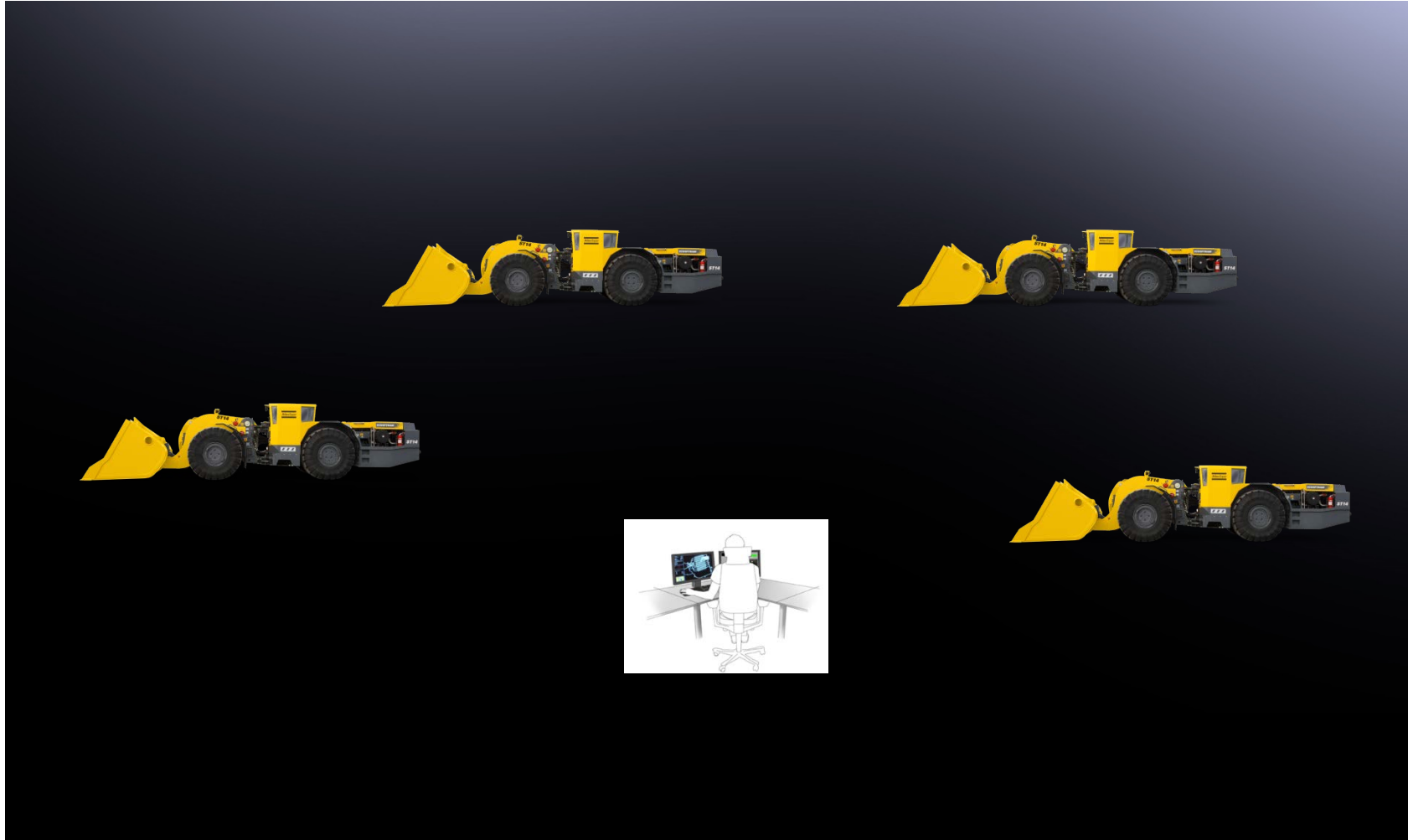
### Remote Sensing (TUC, IBB 2009)

1. Tachymeter with clinometer
2. Radio location and
3. Combination of a laser system and a secondary distance meter





## Autonomous drive of LHD





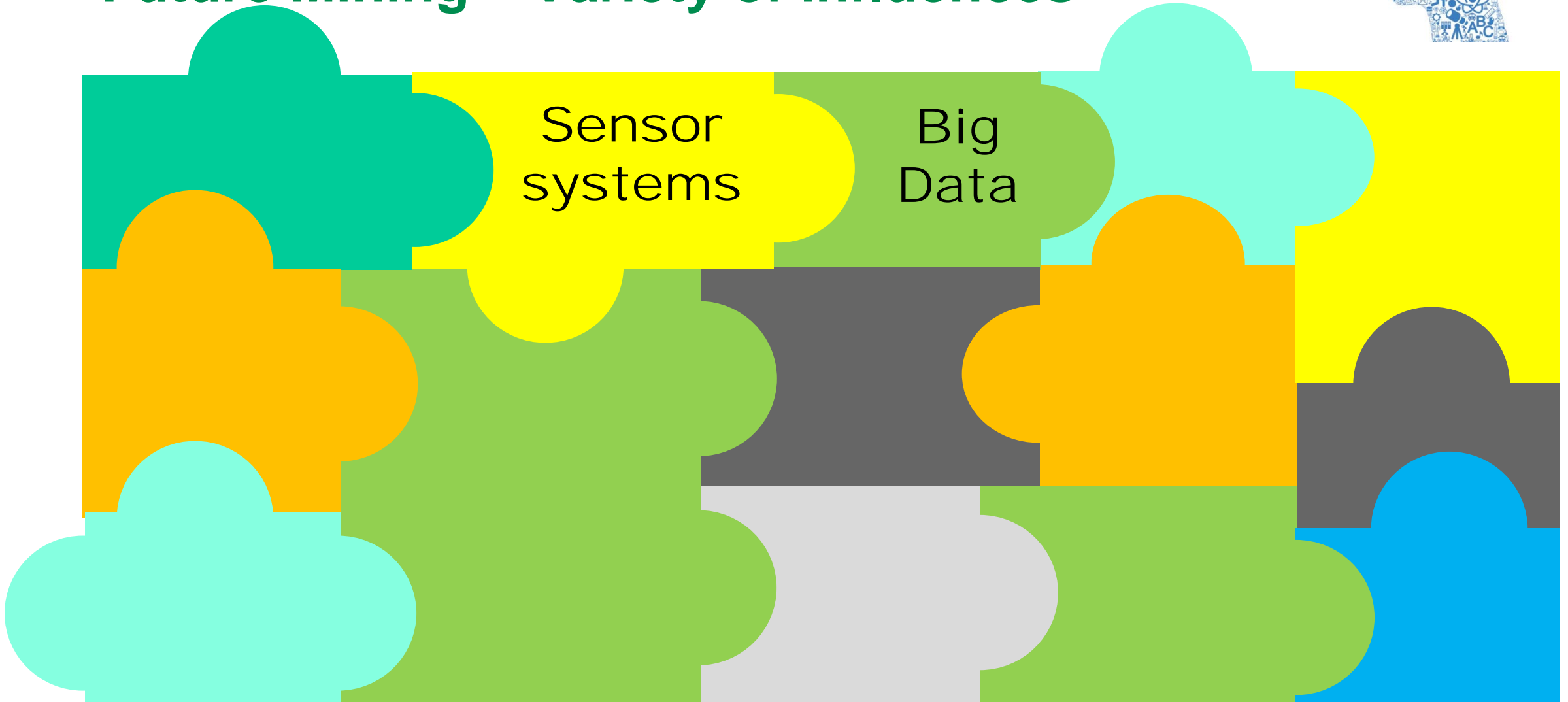
# Autonomous drive of LHD – Remote Control



Bild: Sandvik



# Future Mining – Variety of influences



## Future Mining – Mining 4.0

**Volume and Velocity** concern data Generation, data capturing and data storage

**Veracity and value** concern the quality and the usefulness of the data.  
(information or metadata with no or low real value for the enterprises)

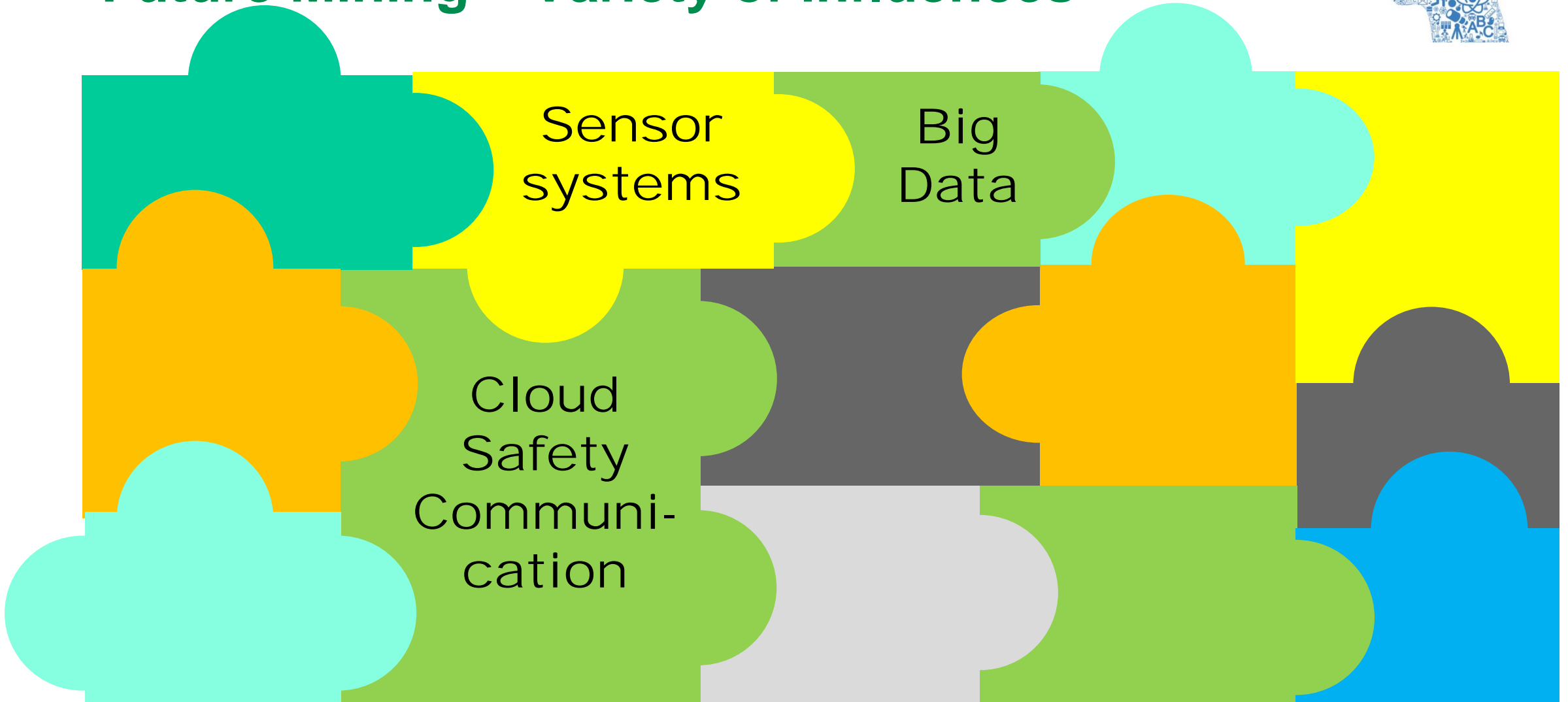
### **Analyse- and Decision-Software**

Evaluation of information and meta data and sorting out of these with poor or no value for companies.

Where necessary transformation of machines to use data and sensors correctly.



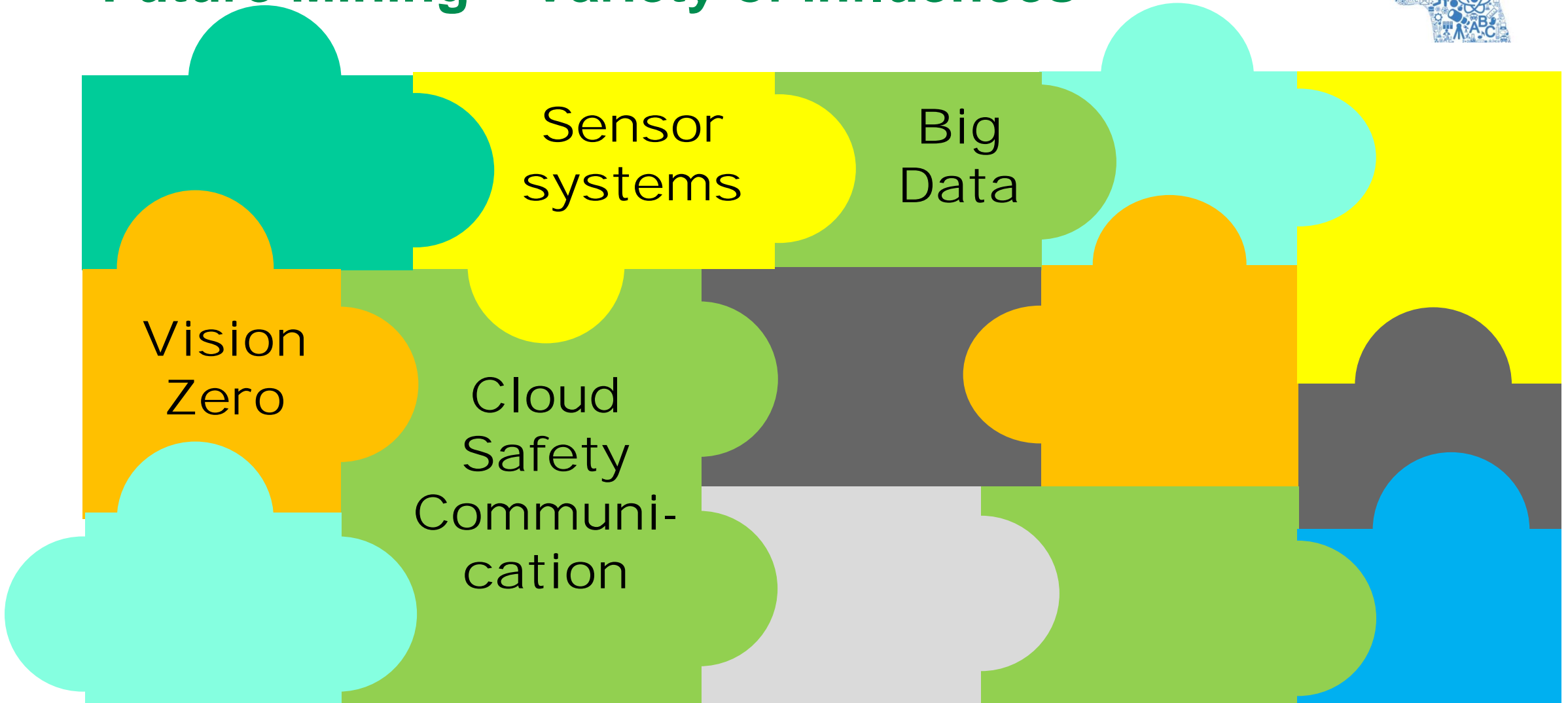
## Future Mining – Variety of influences





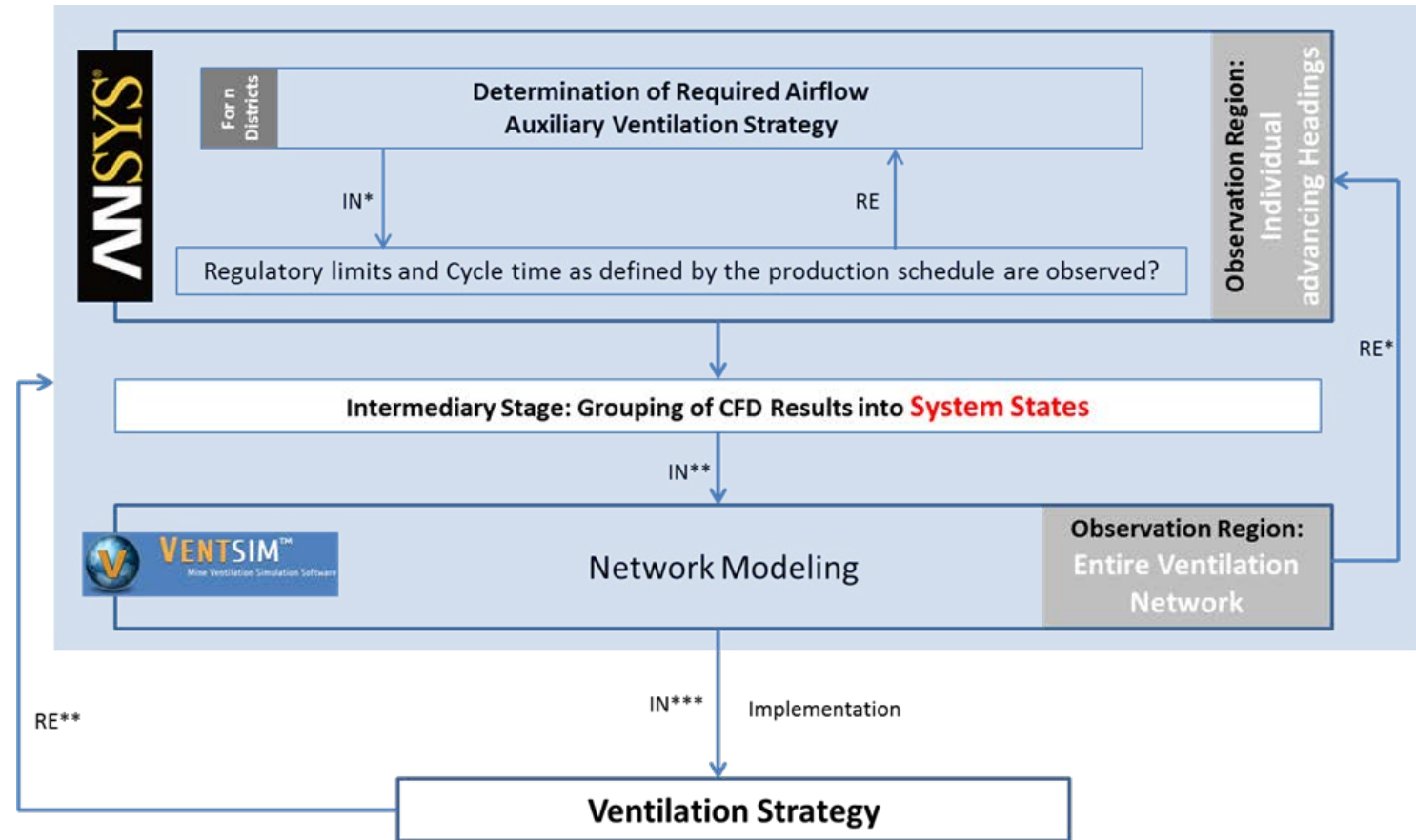


## Future Mining – Variety of influences



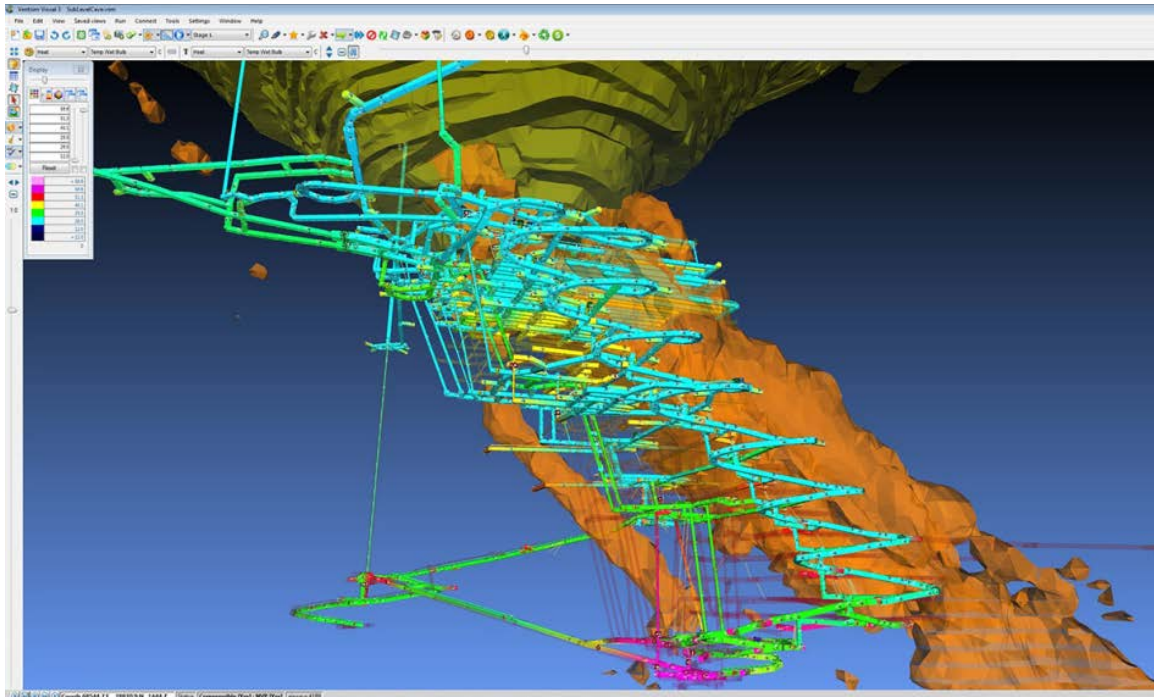


# Ventilation on Demand – CFD Multiphase & Analytical Ventilation Network (IBB-TUC, 2013)

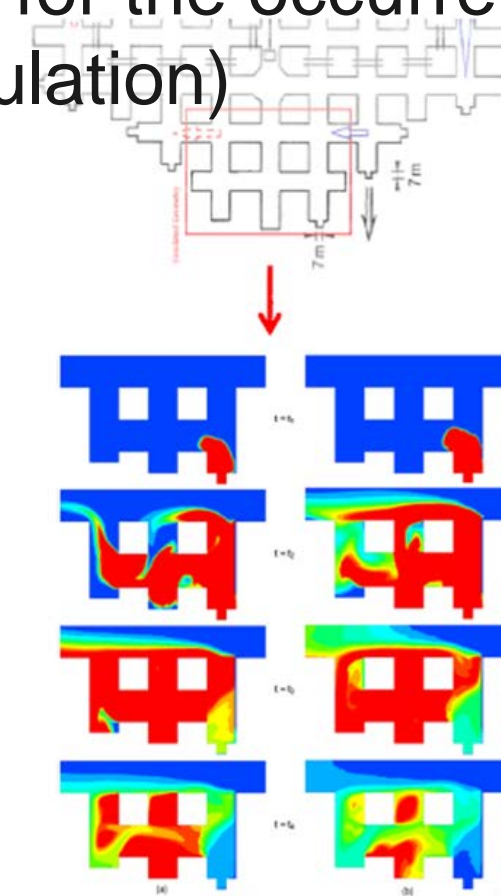


## Ventilation on Demand

Development of a hierarchical approach and methods for a needs-based and efficient ventilation system, especially for the occurrence of gases (analytical methods, numerical flow simulation)



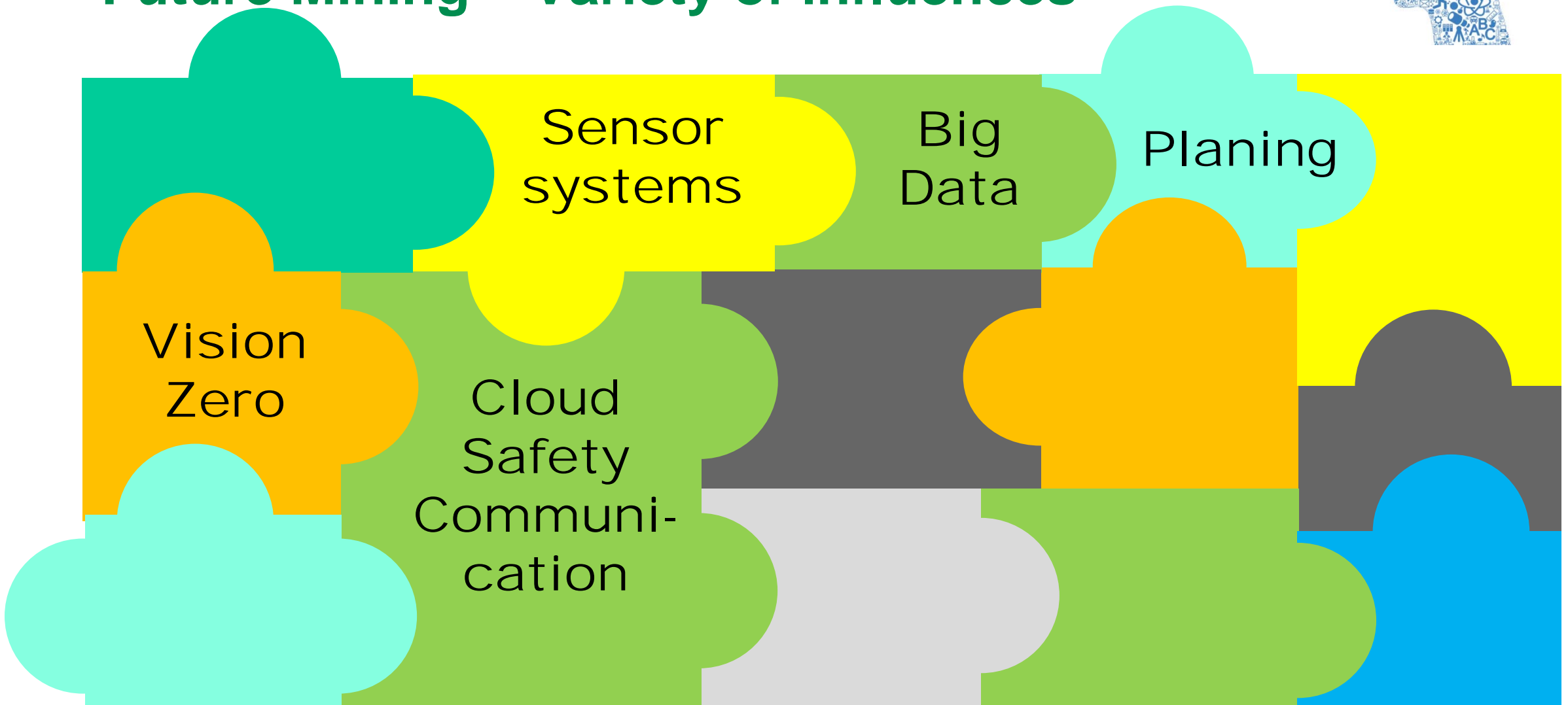
Oliver Langefeld  
Mining Institute  
Clausthal University of Technology (CUT)



Gas Concentration Contours

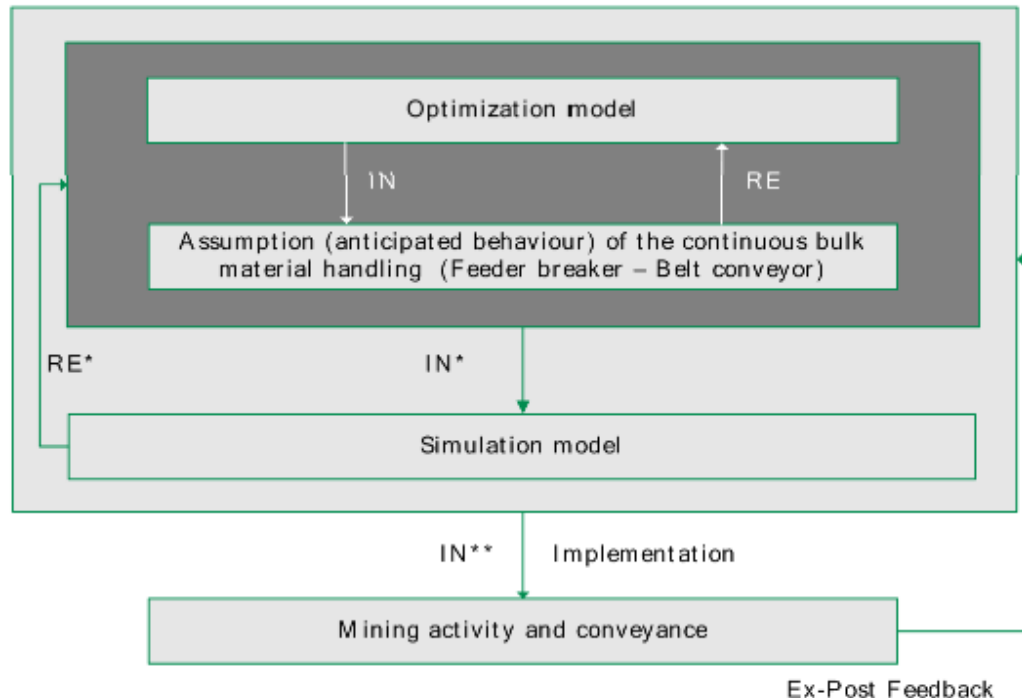
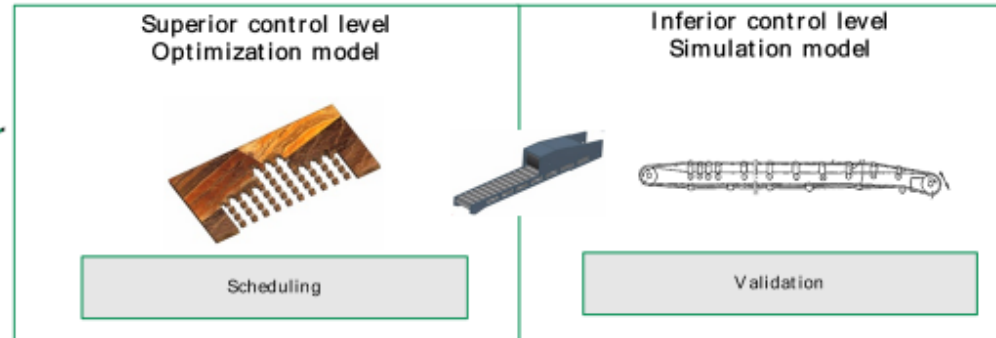


## Future Mining – Variety of influences





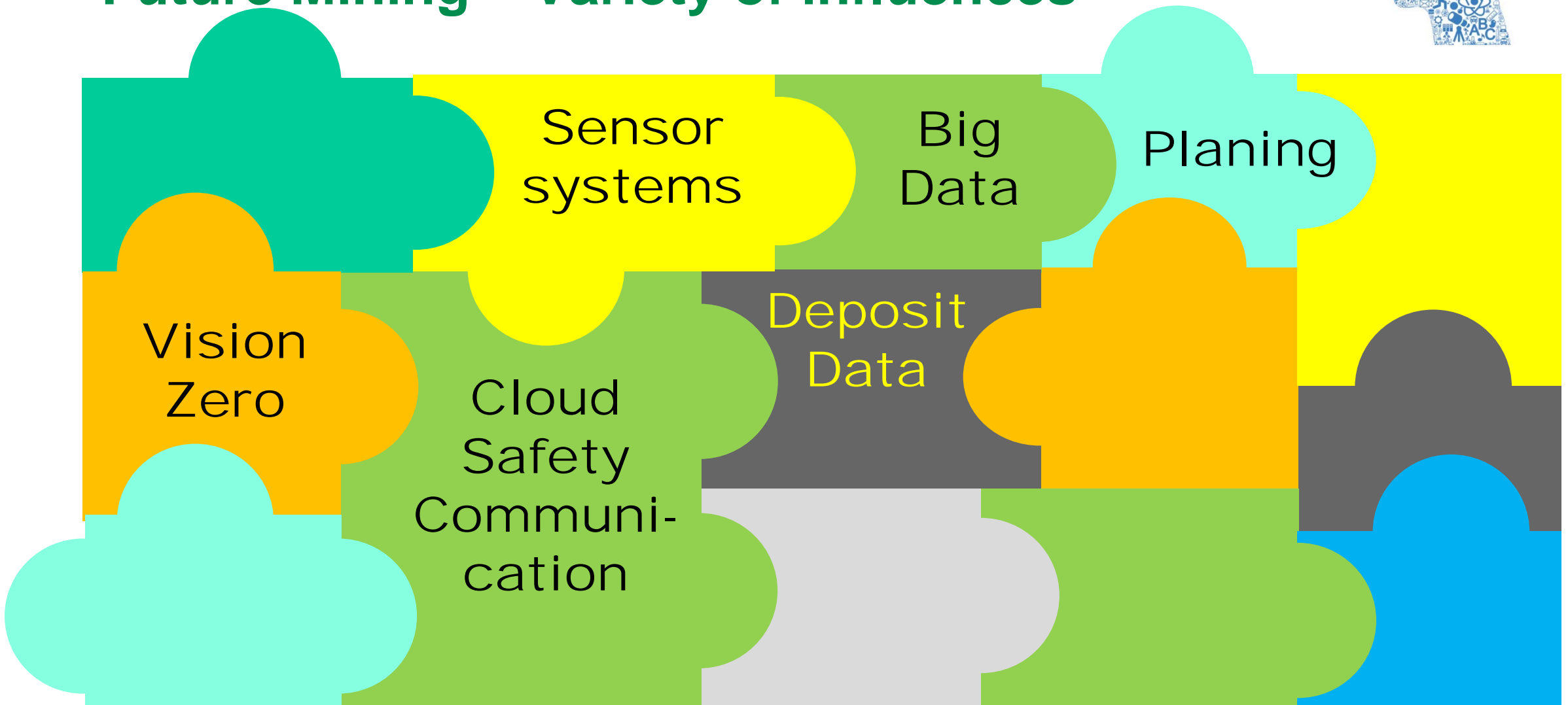
# Hierarchical Approach for Mine Planing (IBB – TUC, 2011)



Dissertation Dr. Elisabeth Clausen

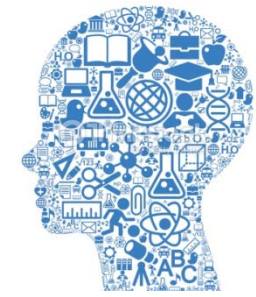


## Future Mining – Variety of influences





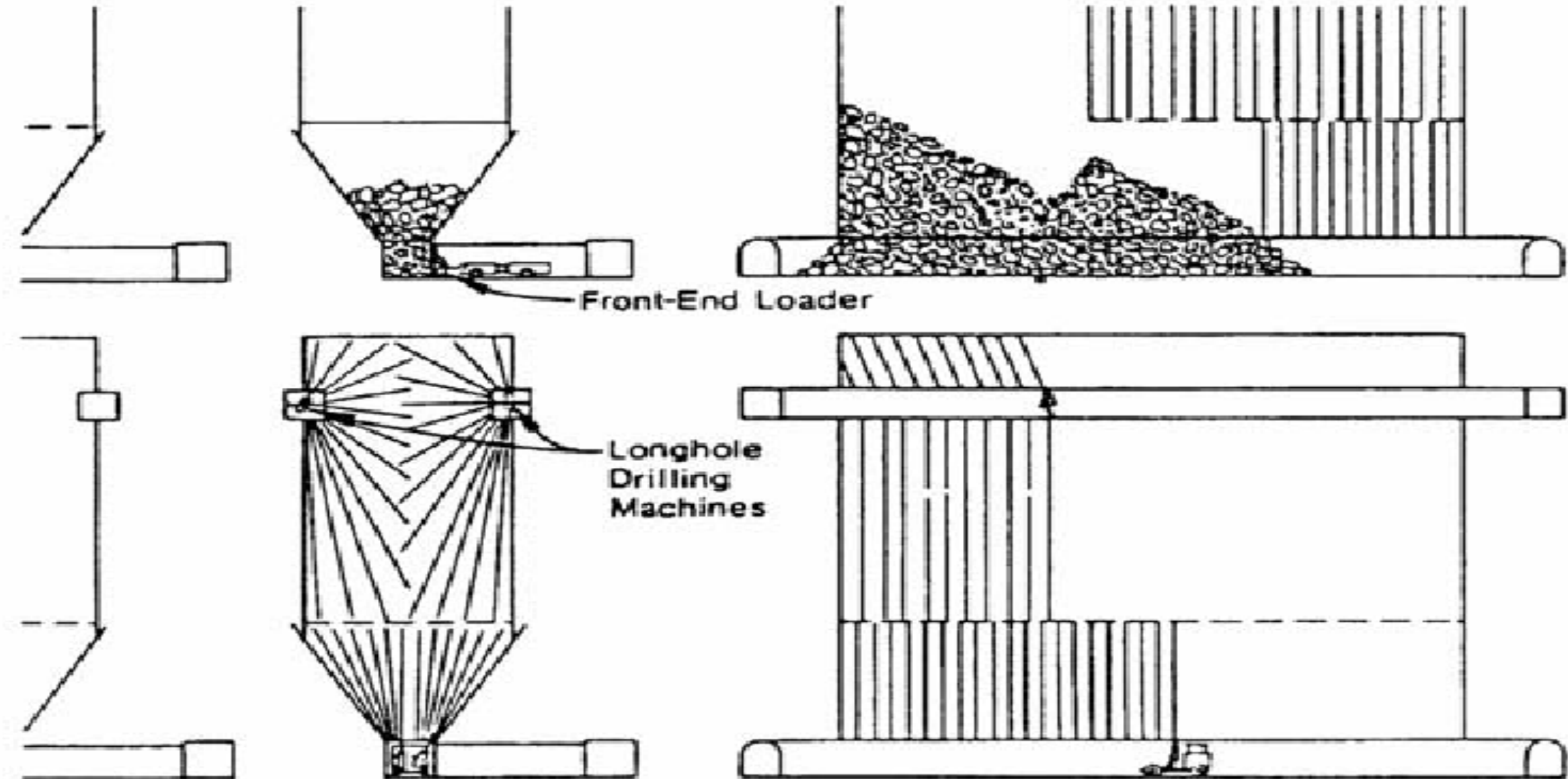
## Measurement while Drilling



**Bild: Hazemag**



## Sublevel Open Stopping – extraction







## Fragmentation of blasted rock



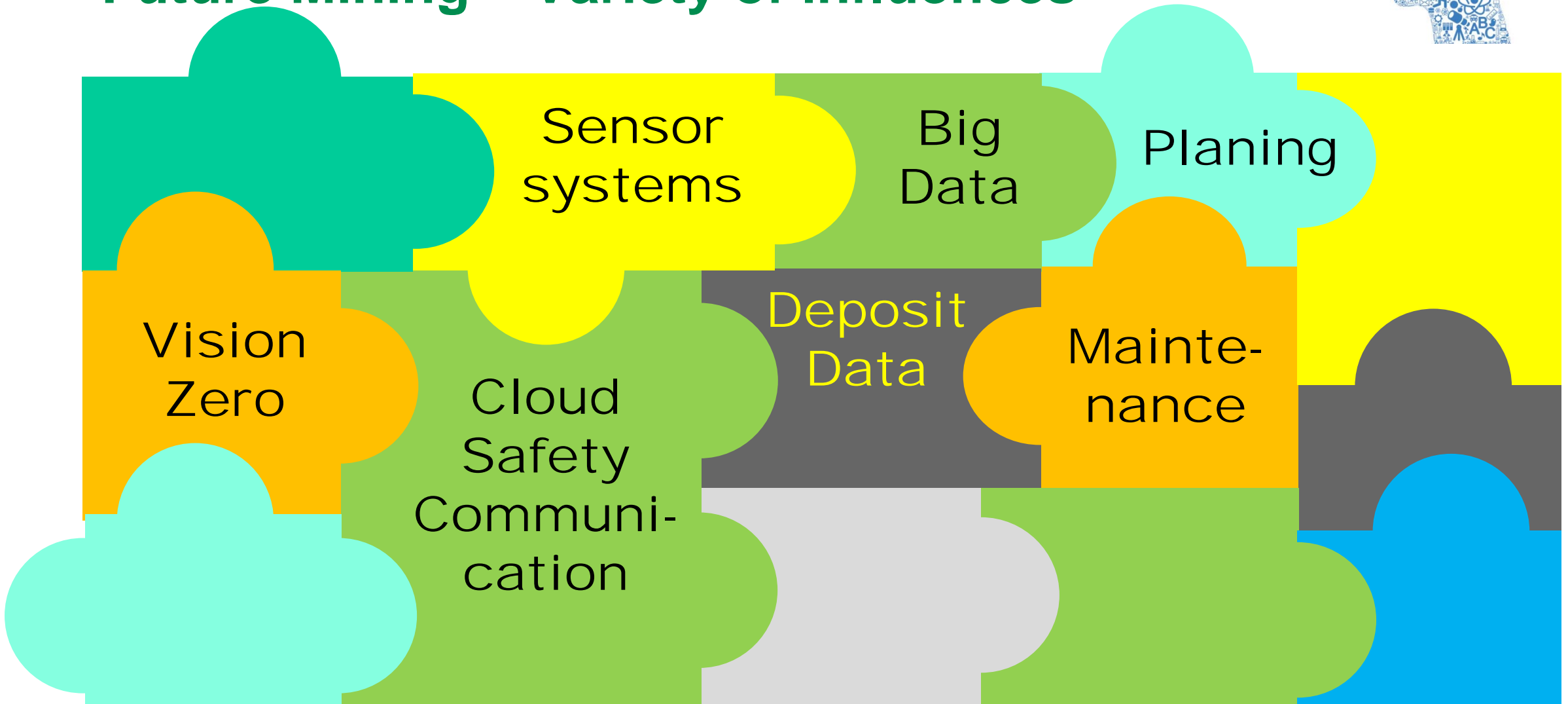
**Very good fragmentation**



**Drilling & Blasting**



## Future Mining – Variety of influences



## Condition Monitoring (CM)

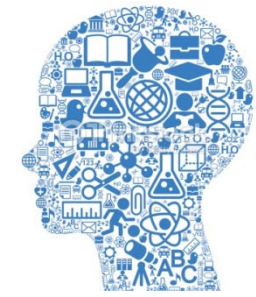
Over usage of techniques and instruments make CM costly.

Misunderstanding the principles underlying CM, especially capability and applicability.

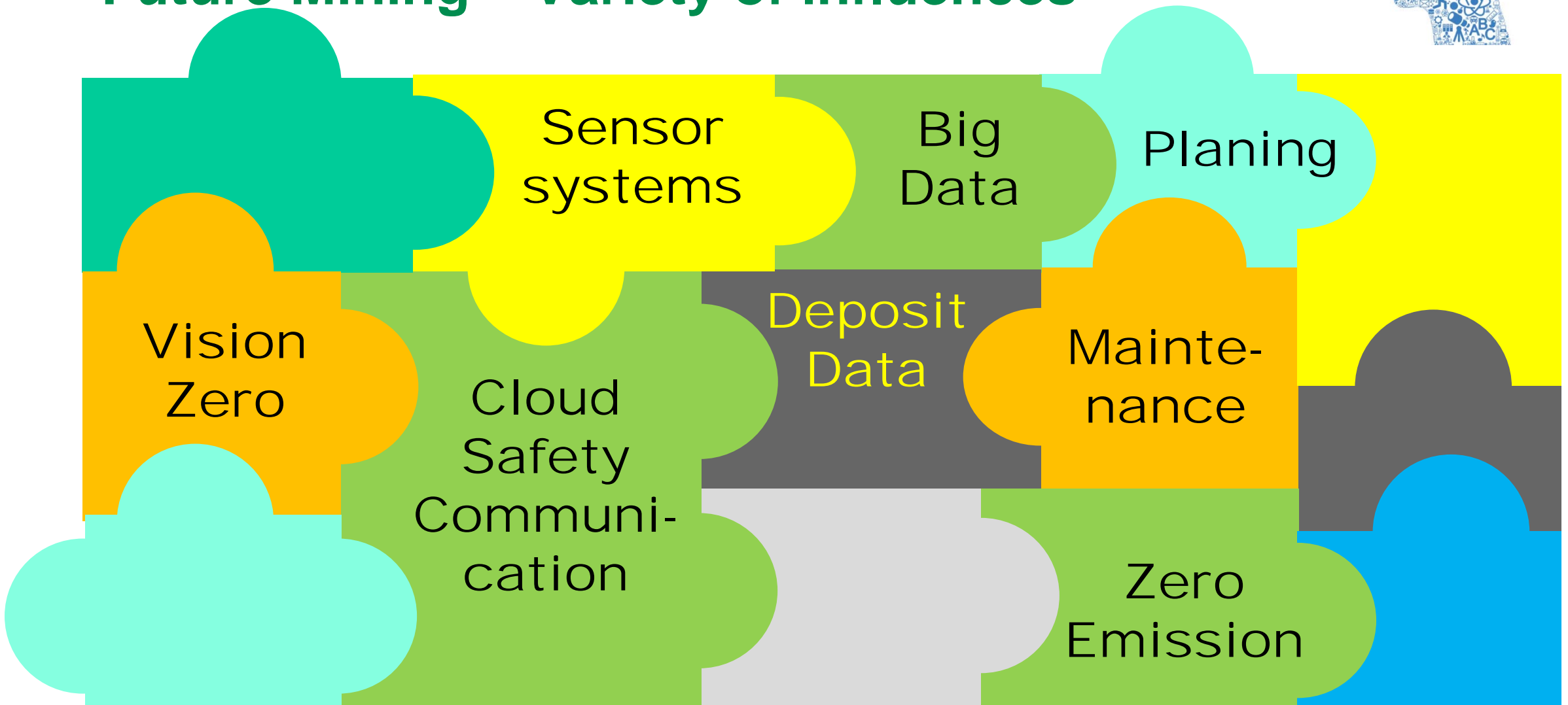
Difficulty in interpreting complex and voluminous data and, therefore, in diagnosing incipient faults

Difficulty in determining the critical levels on which repair/replacement decisions should be based.

Difficulty estimating accurate remaining useful life.

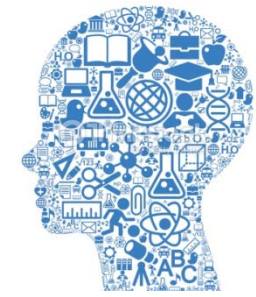


## Future Mining – Variety of influences



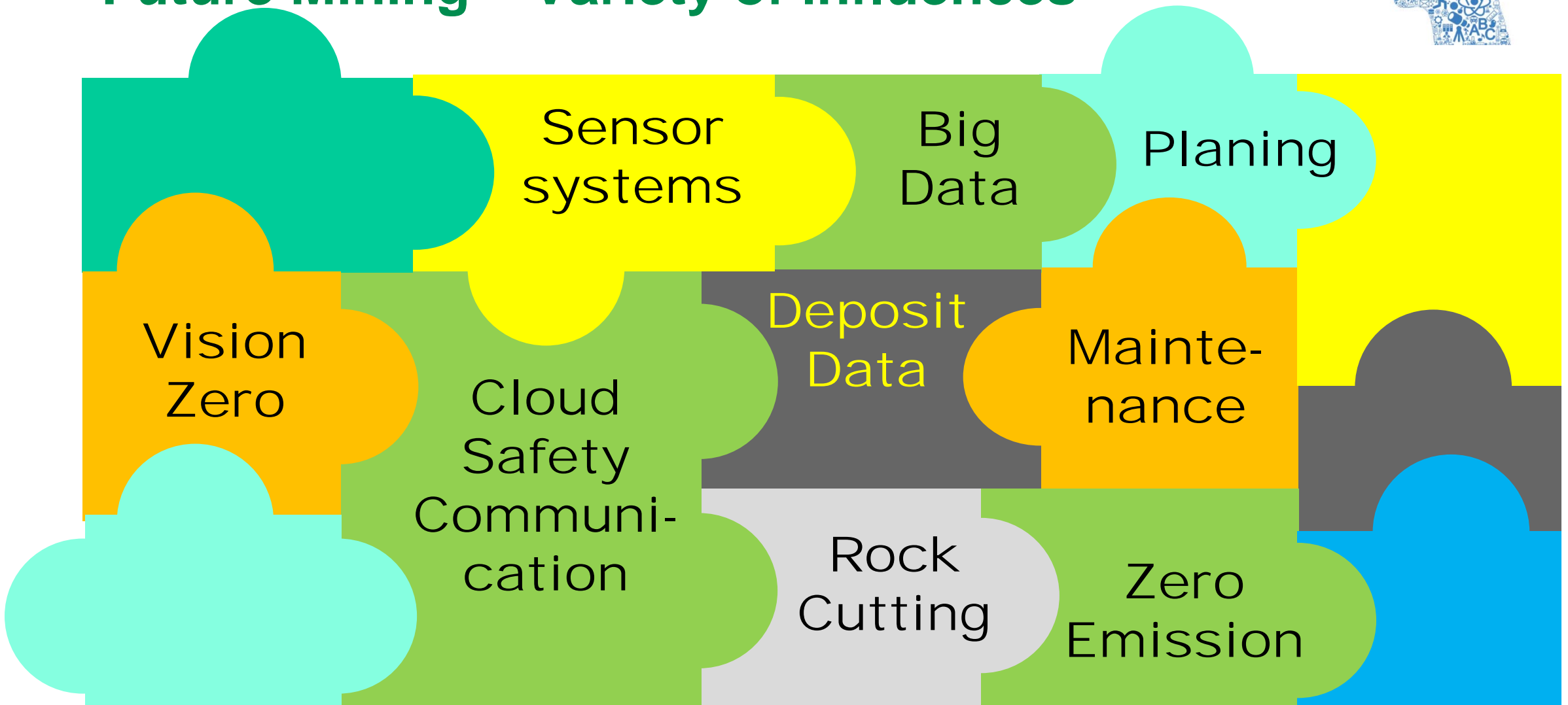


## Center for battery testing at Clausthal UT





## Future Mining – Variety of influences



## European Rock Extraction Group launched

(Mining Magazin 21-09-16)



Oliver Langefeld  
Mining Institute  
Clausthal University of Technology (CUT)

## Extraction System in Longwall Mining





## Hard Rock Miner HRM220

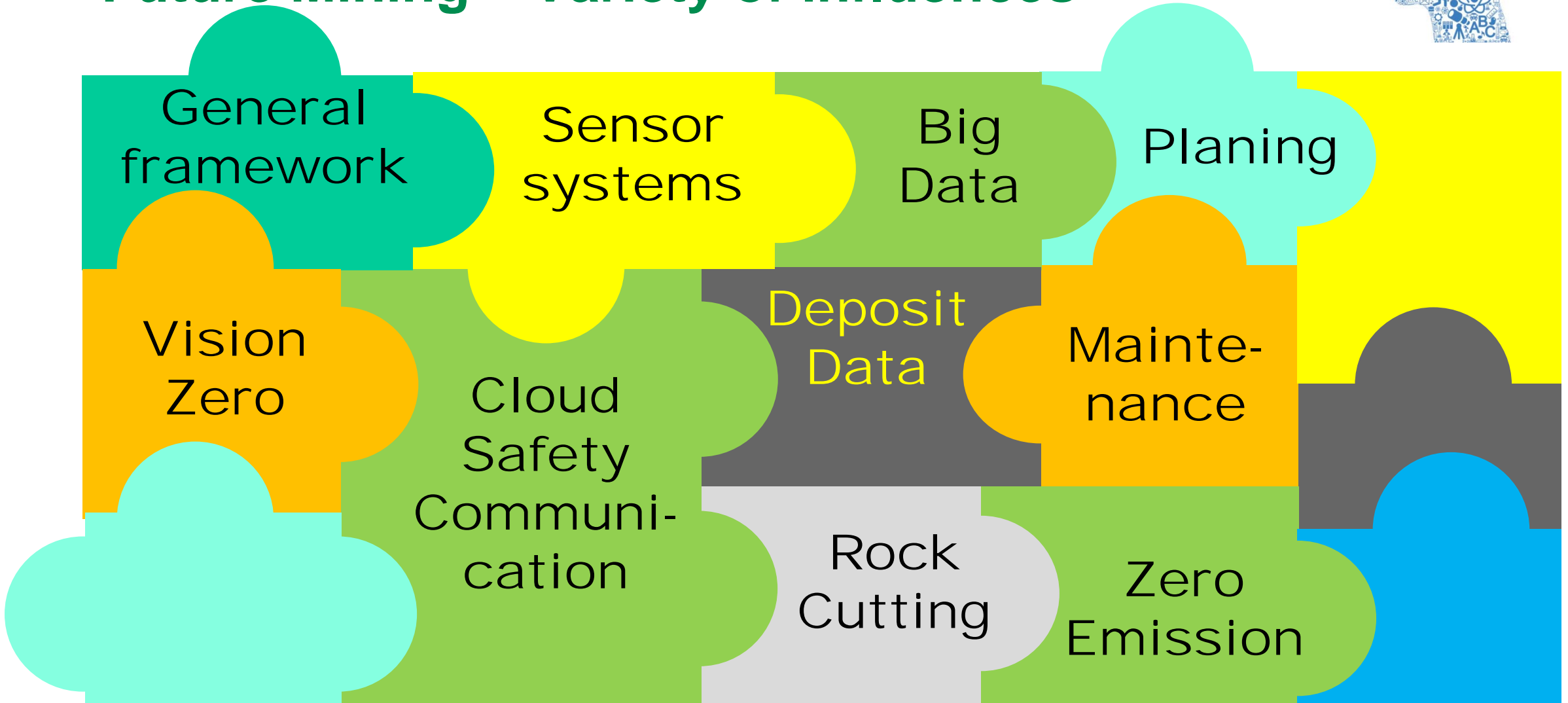


**...equipped with  
CAT Activated  
Undercutting  
Technology**

Range of cutting height	1.3 – 2.0 m
Installed Power per Cutting Unit	132 kW
Installed Power Electrical System	319 kW
Cutting Depth per Unit	100 mm
Maximum Advance Rate	6 m/minute
Instantaneous Cutting Rate	Up to 175 tonnes/hour
Operating Voltage	1,000 V

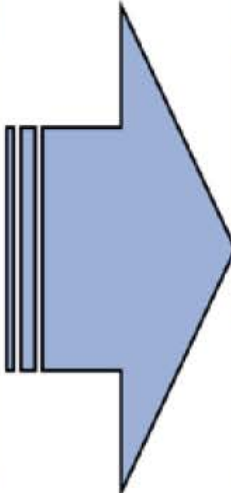


## Future Mining – Variety of influences





## Determination of maximum admissible workplace concentration

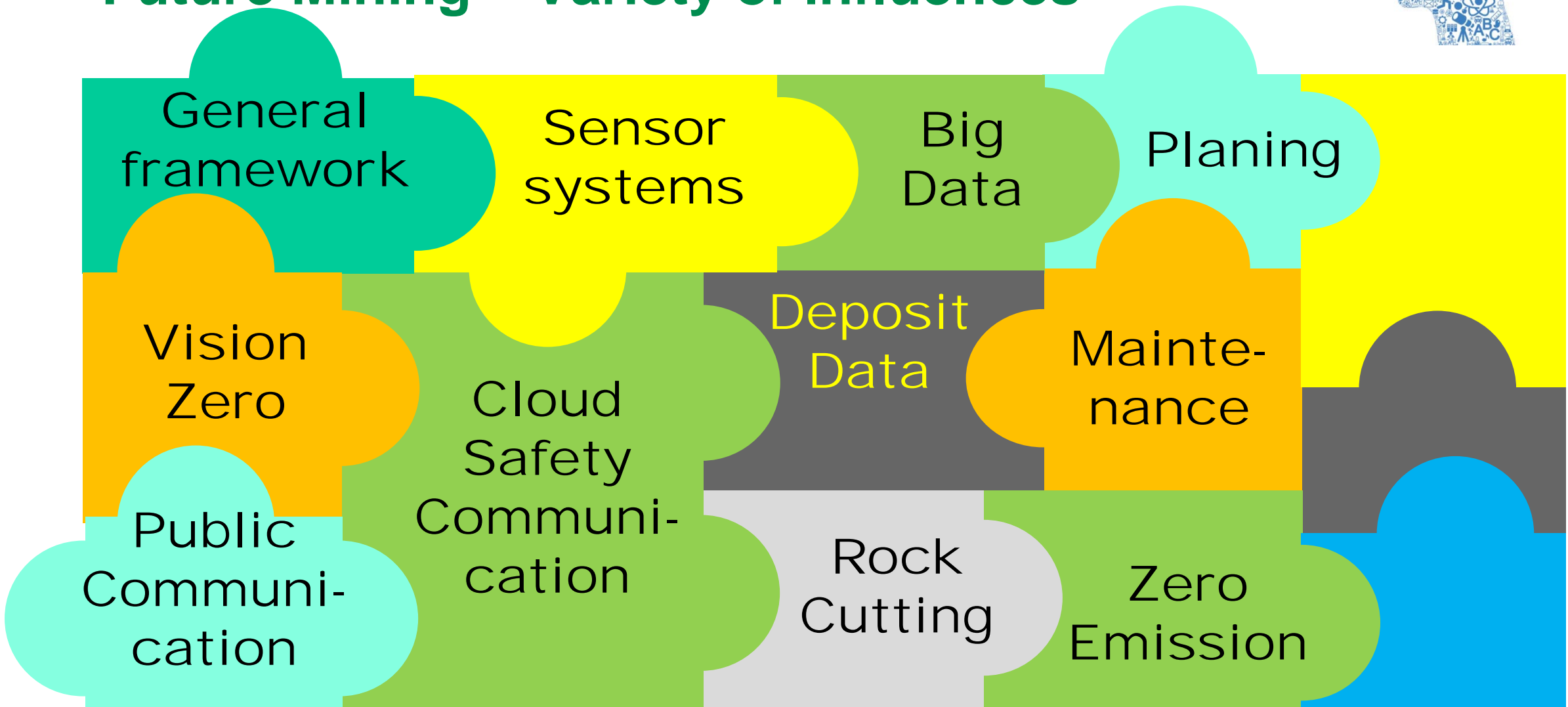
	Deutschland bisher	USA in Kraft	Canada (ON, QB) in Kraft		Deutschland aktuell
Stickstoffmonoxid NO	(25 ppm)	25 ppm	25 ppm		2 ppm
Stickstoffdioxid NO <sub>2</sub>	(5 ppm)	5 ppm	3 ppm		0,5 ppm
Diesel Partikelemissionen DME	300 µg/m <sup>3</sup> EC <sup>1</sup> (unter Tage)	160 µg/m <sup>3</sup> TC <sup>2</sup> 80 µg/m <sup>3</sup> TC	400 µg/m <sup>3</sup> TC (240 µg/m <sup>3</sup> EC)		(50 µg/m <sup>3</sup> EC)

<sup>1</sup> EC: Elemental Carbon

<sup>2</sup> TC: Total Carbon



## Future Mining – Variety of influences



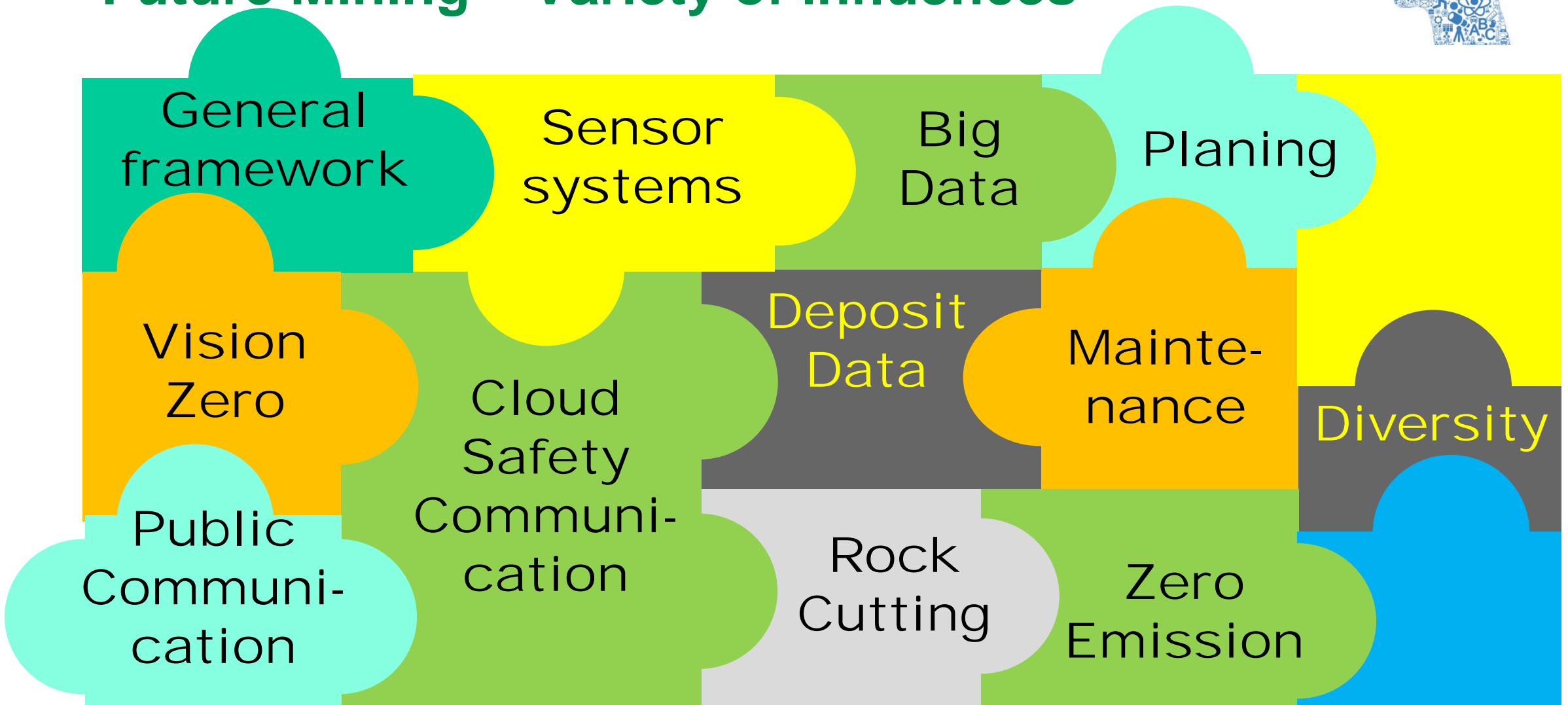
## Top 10 business risks facing mining and metals

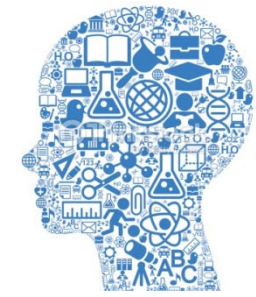
Top 10 risks	2016-2017	
	01	Cash optimization
	02	Capital access
	03	Productivity
	04	Social license to operate
	05	Transparency
	06	Switch to growth
	07	Access to energy
	08	Joint ventures
	09	Cybersecurity
	10	Innovation

EY (Ernst & Young)  
Building a better working world

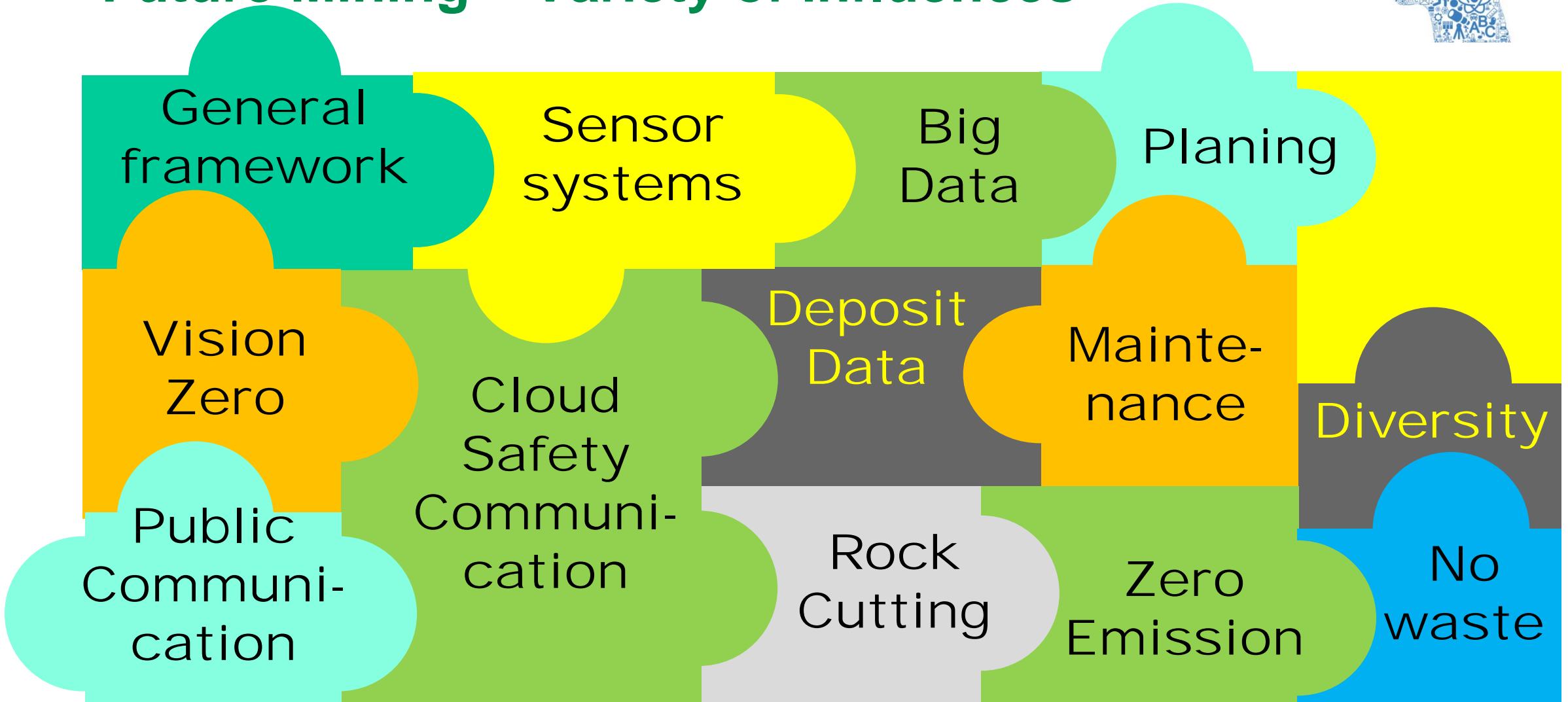


## Future Mining – Variety of influences





## Future Mining – Variety of influences



## Mine Waste

- Deposits are deeper
- Deposits are more complex
- Grade of deposits are smaller



**That leads to**

**More excavated material and tailings**



# Waste dam in Potash Mining Industry in Germany

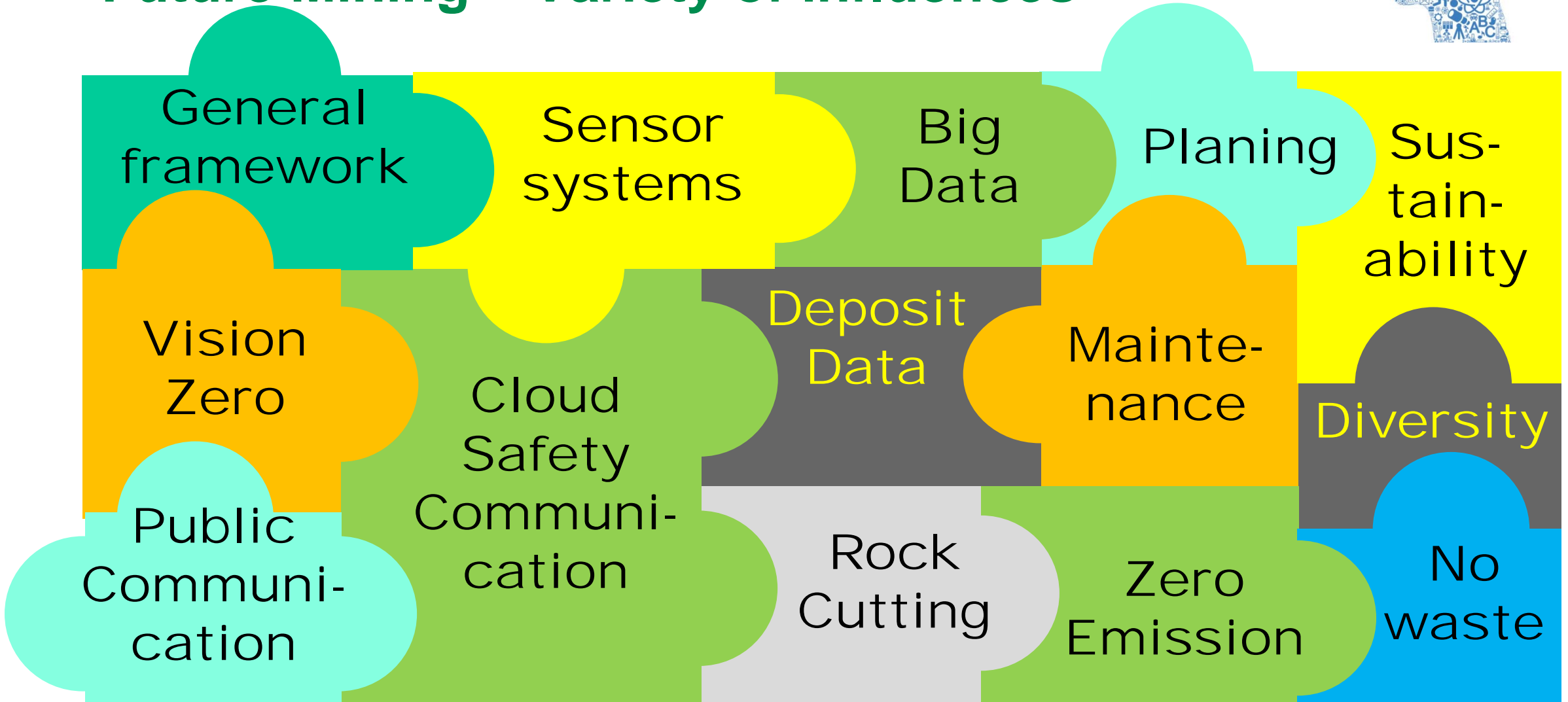


## Tailing dam in Flourspar Mine Derbyshire, England

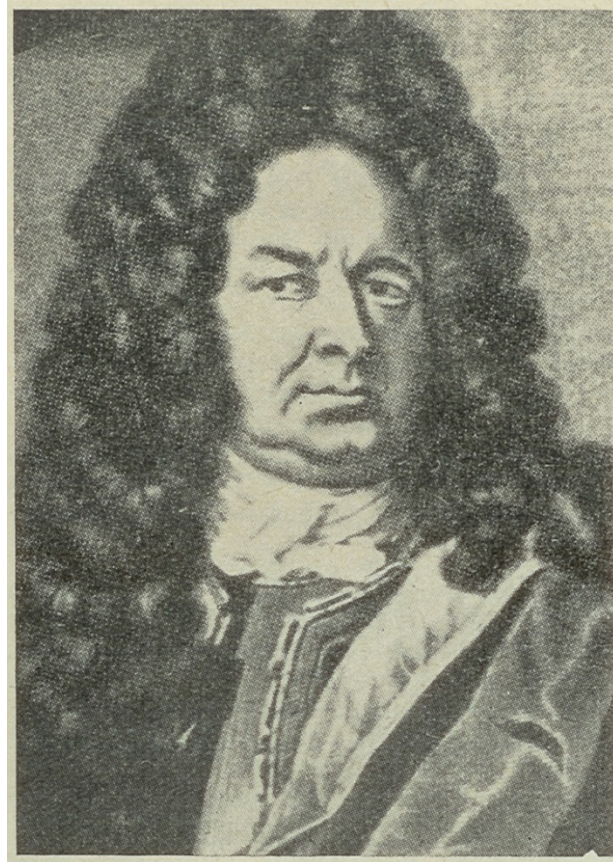




## Future Mining – Variety of influences







**Hans Carl von Carlowitz**  
**Head of Saxonian Mine Authority**  
**1645 - 1714**



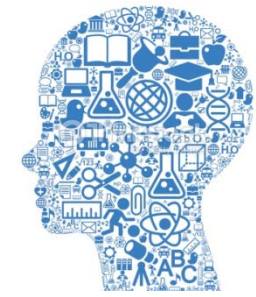
## Brundtland Commission in 1987



**“Sustainable development is development that meets the needs of the present without compromising the **ability of future generations to meet their own needs.**”**

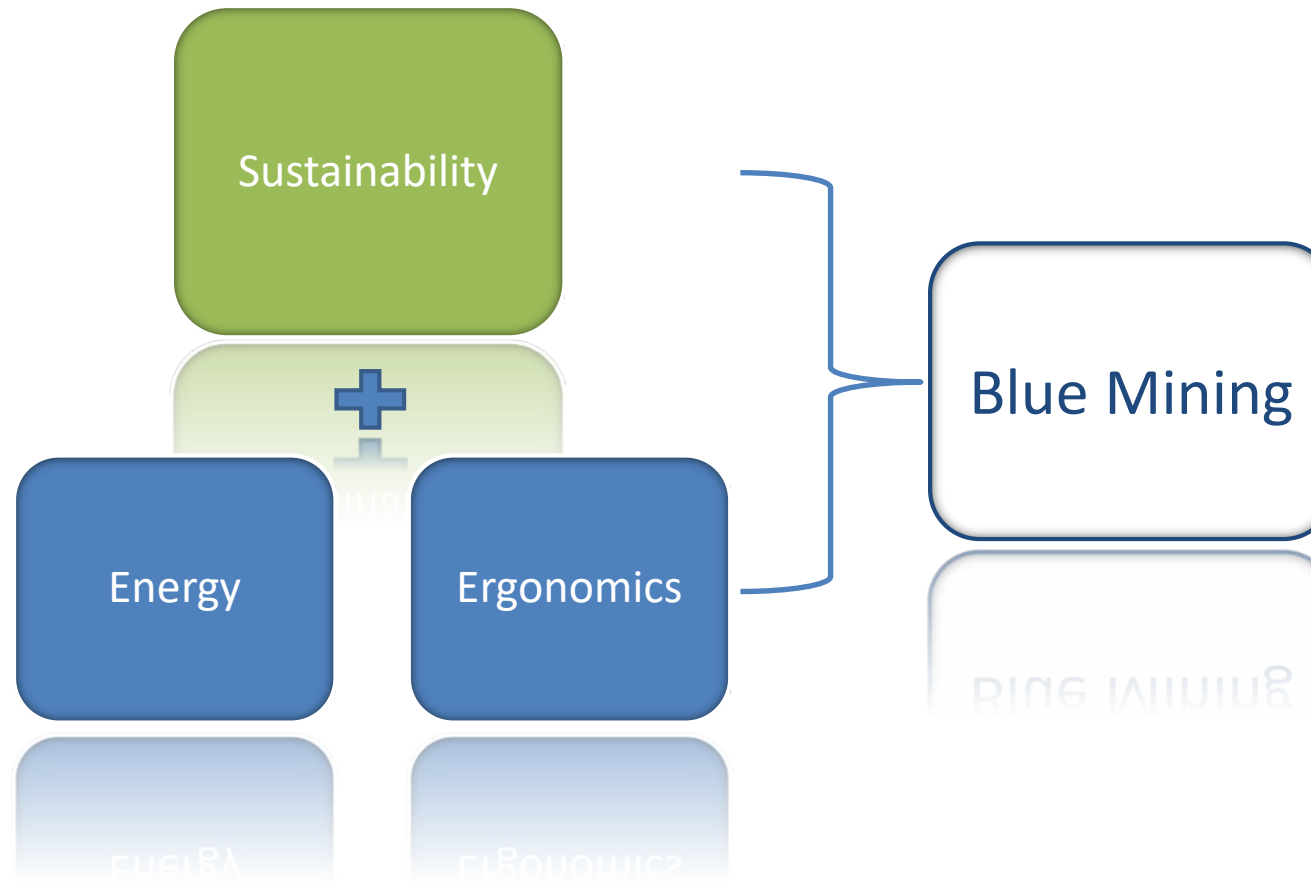


## „Blue Mining“ New concepts for Mines



The term of „**Blue mining**“ was first introduced from CUT in Summer 2013 at „World Mining Congress“, Canada and „SDIMI-Congress“ Milos, 1. July 2013

## Blue Mining - Definition



**Definition and declaration of post-use in the planning phase of a mine**

# TU Clausthal

## Energy Efficiency



Sources: Roessing Uranium; Welterbe  
Rammelsberg, Breuer Motoren

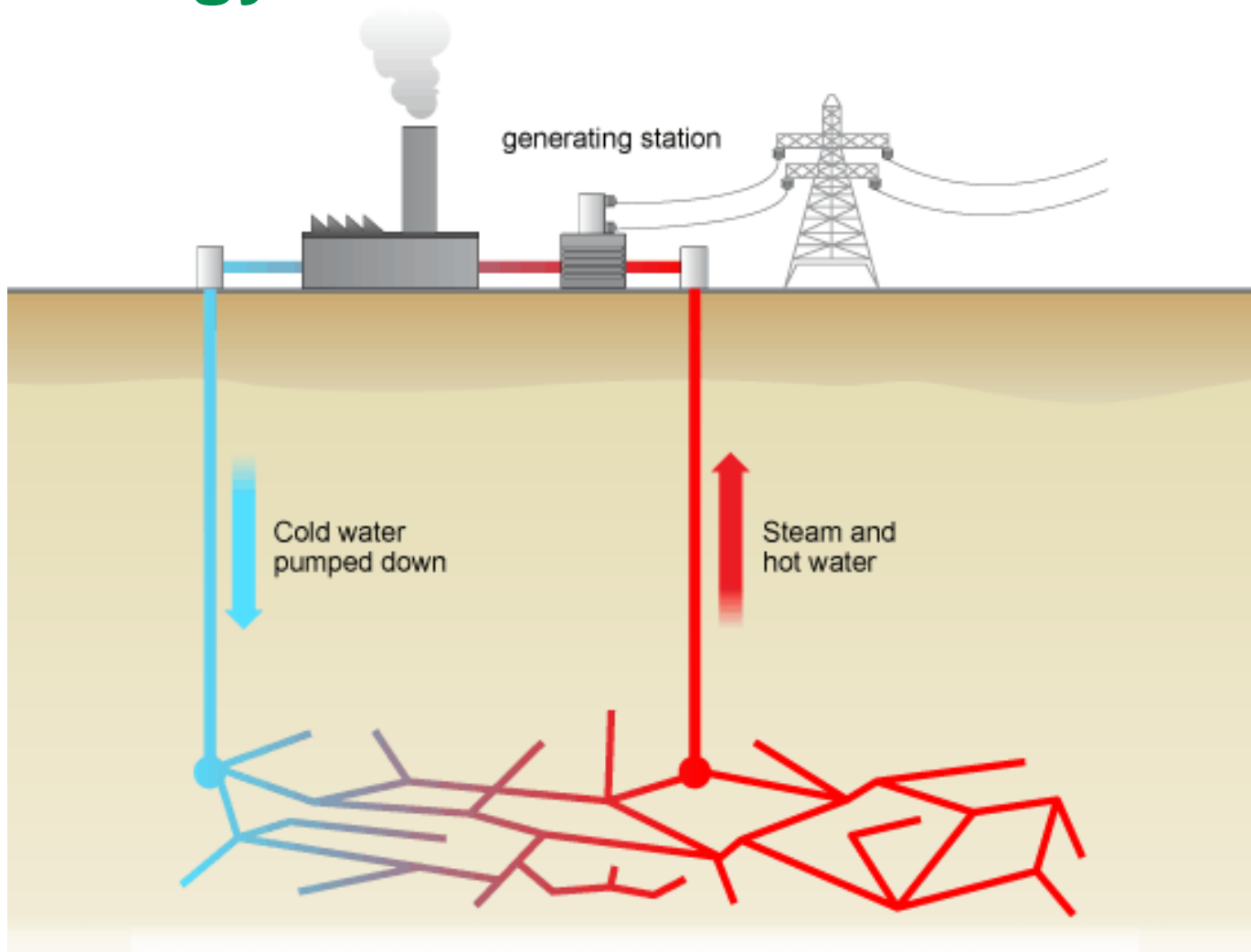
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Mining Institute  
Clausthal University of Technology (CUT)





# TU Clausthal

## Energy Production

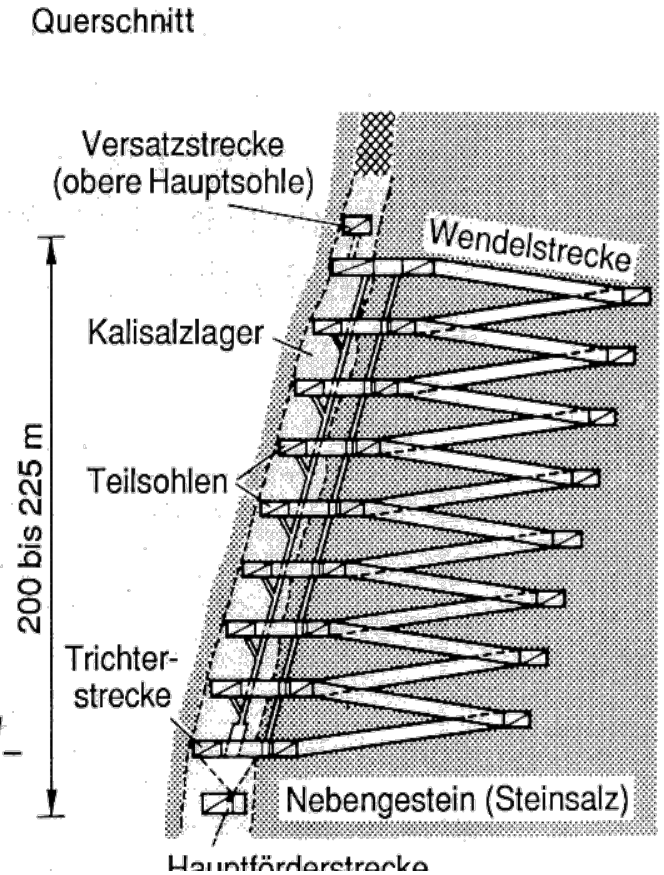
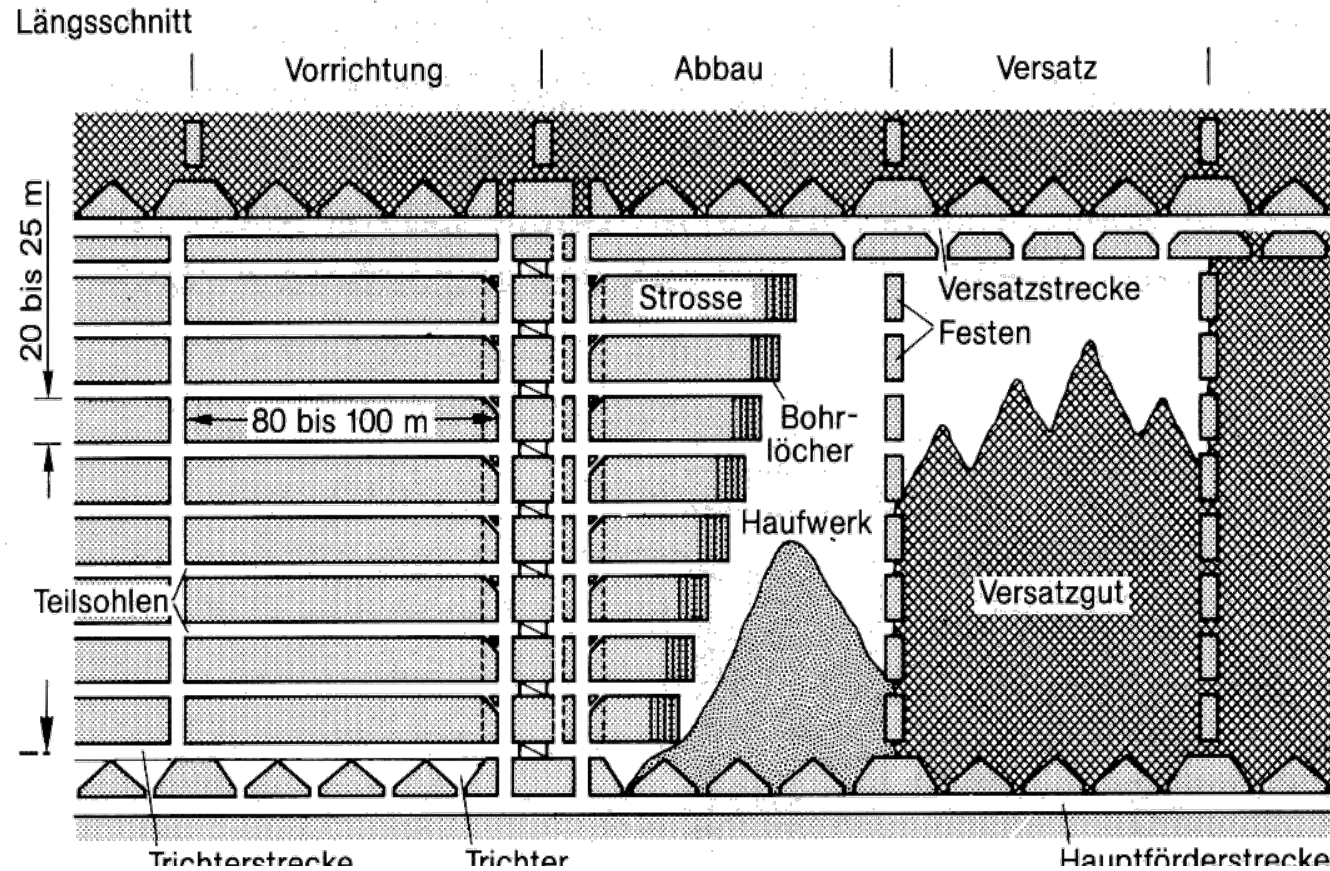


Oliver Langefeld  
Mining Institute  
Clausthal University of Technology (CUT)



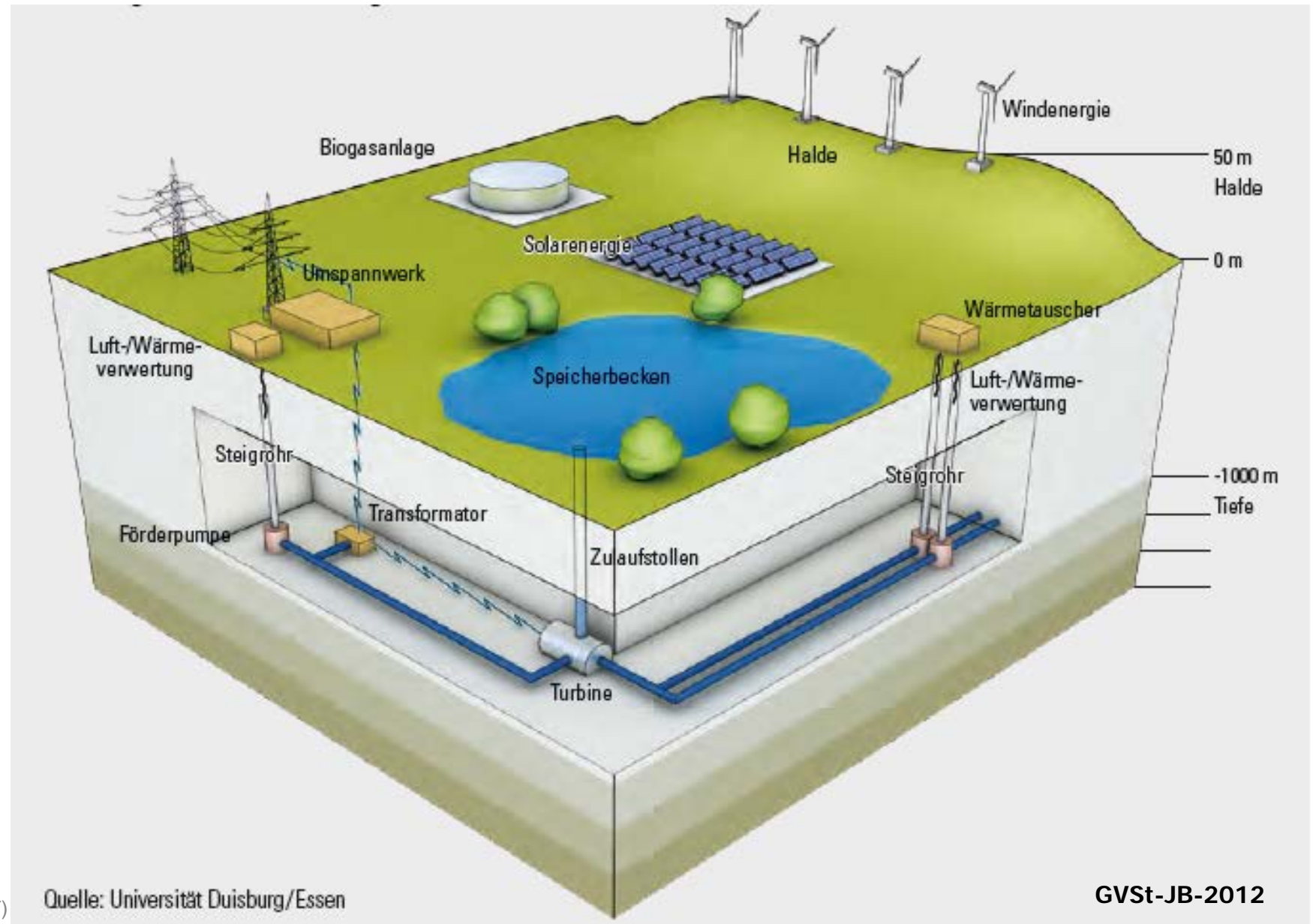
Sources: BBC UK, K+S KALI GmbH

# Energy Production

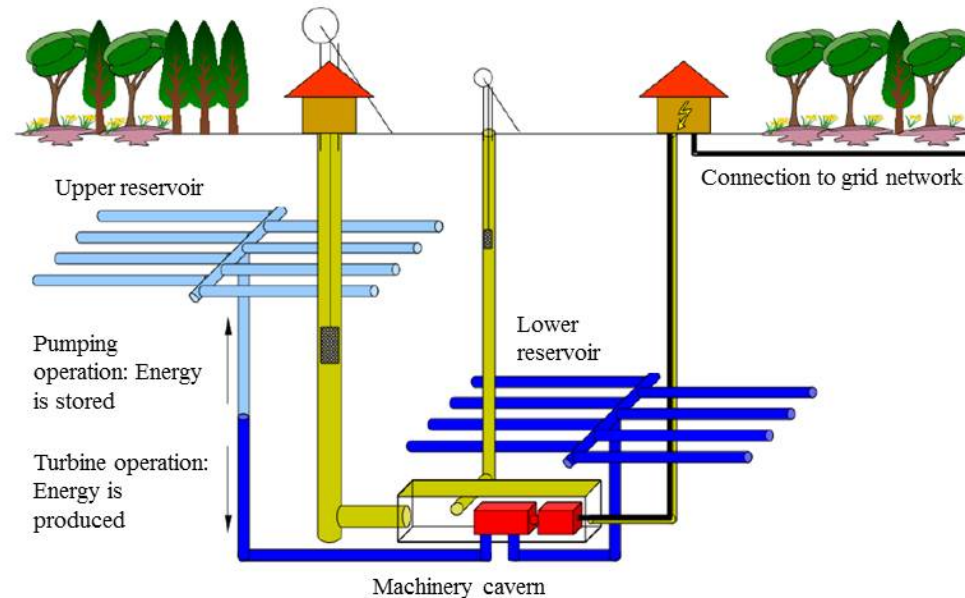


A very deep and hot potash mine





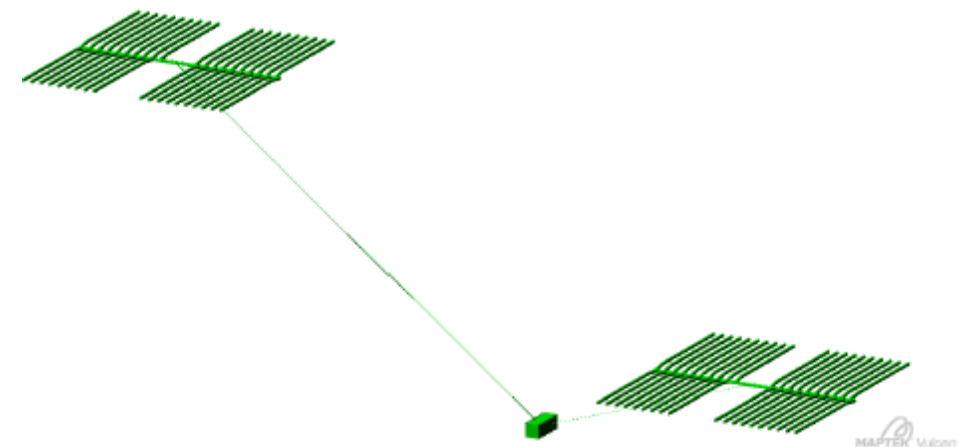
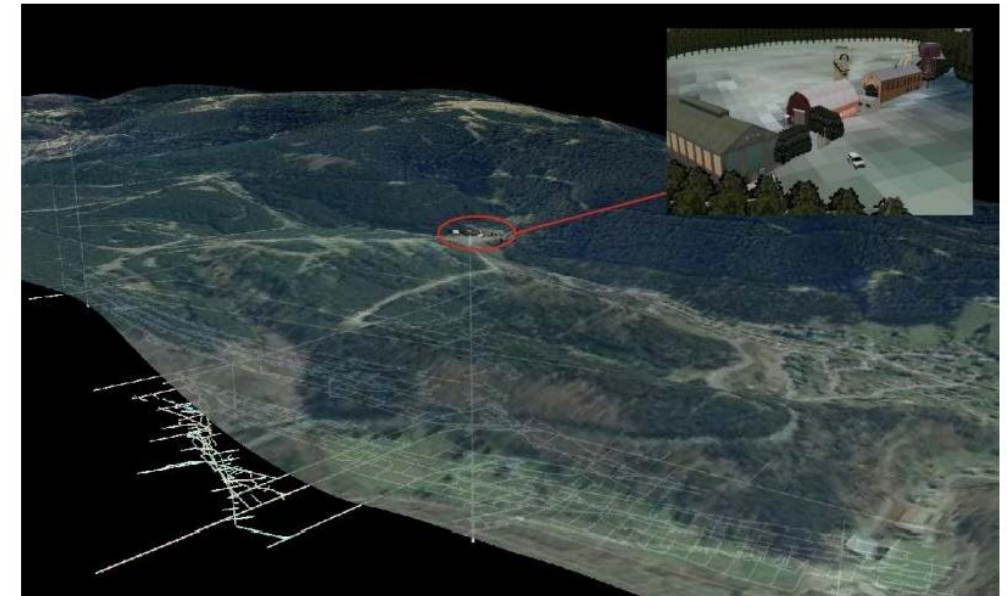
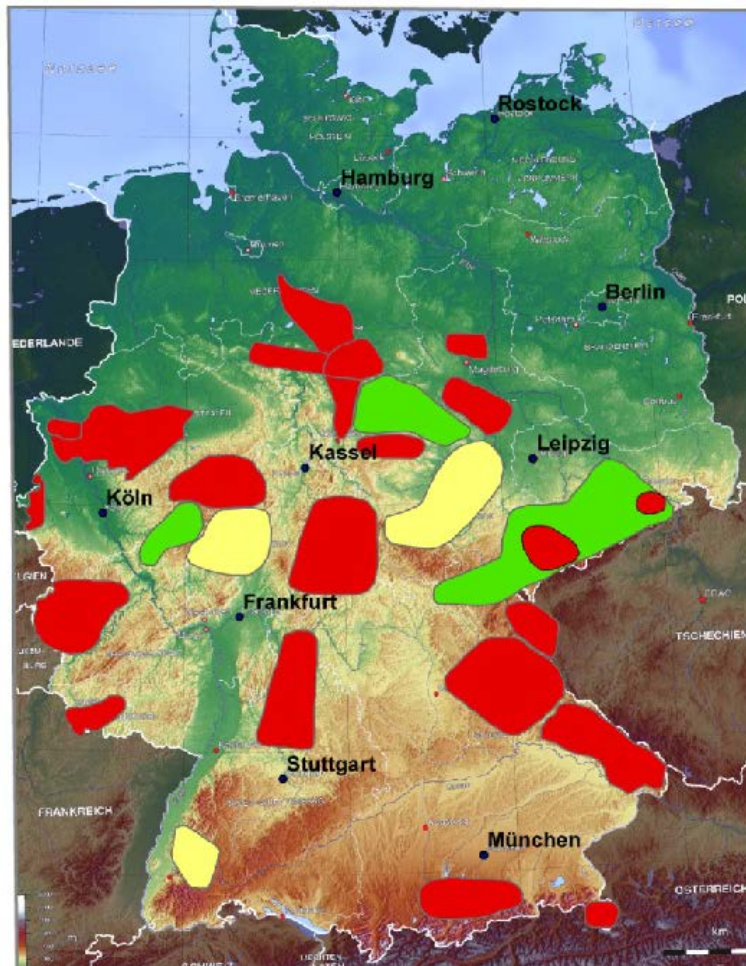
## Underground Pump Storage



Transdisciplinary research project of EFZN at Clausthal UT „**Wind energy storage by using abandonend mine sites**“

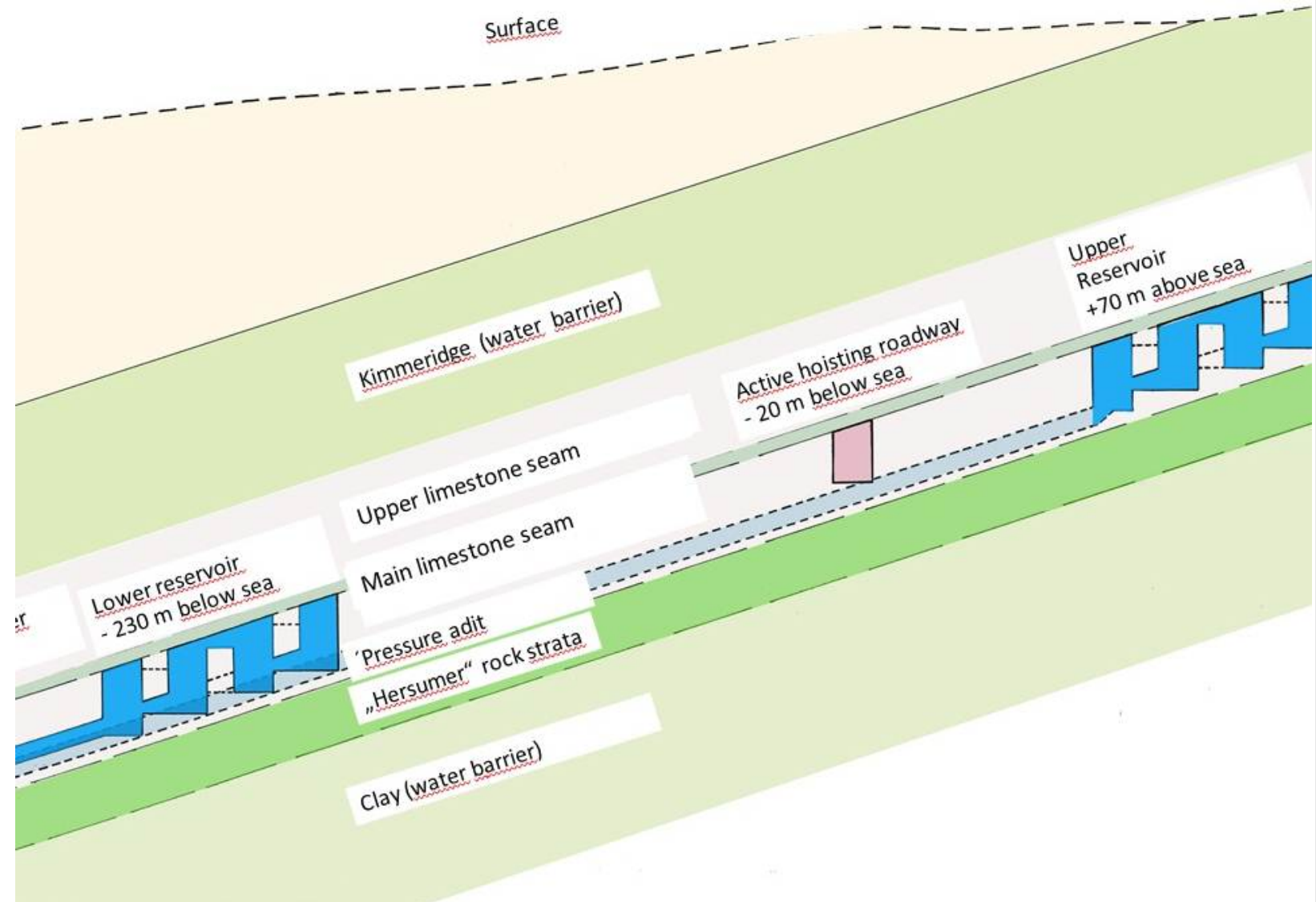
2008 – 2011, 864 pages

## Underground Pump Storage – abandoned mine usage





# Underground Pump Storage – active mine



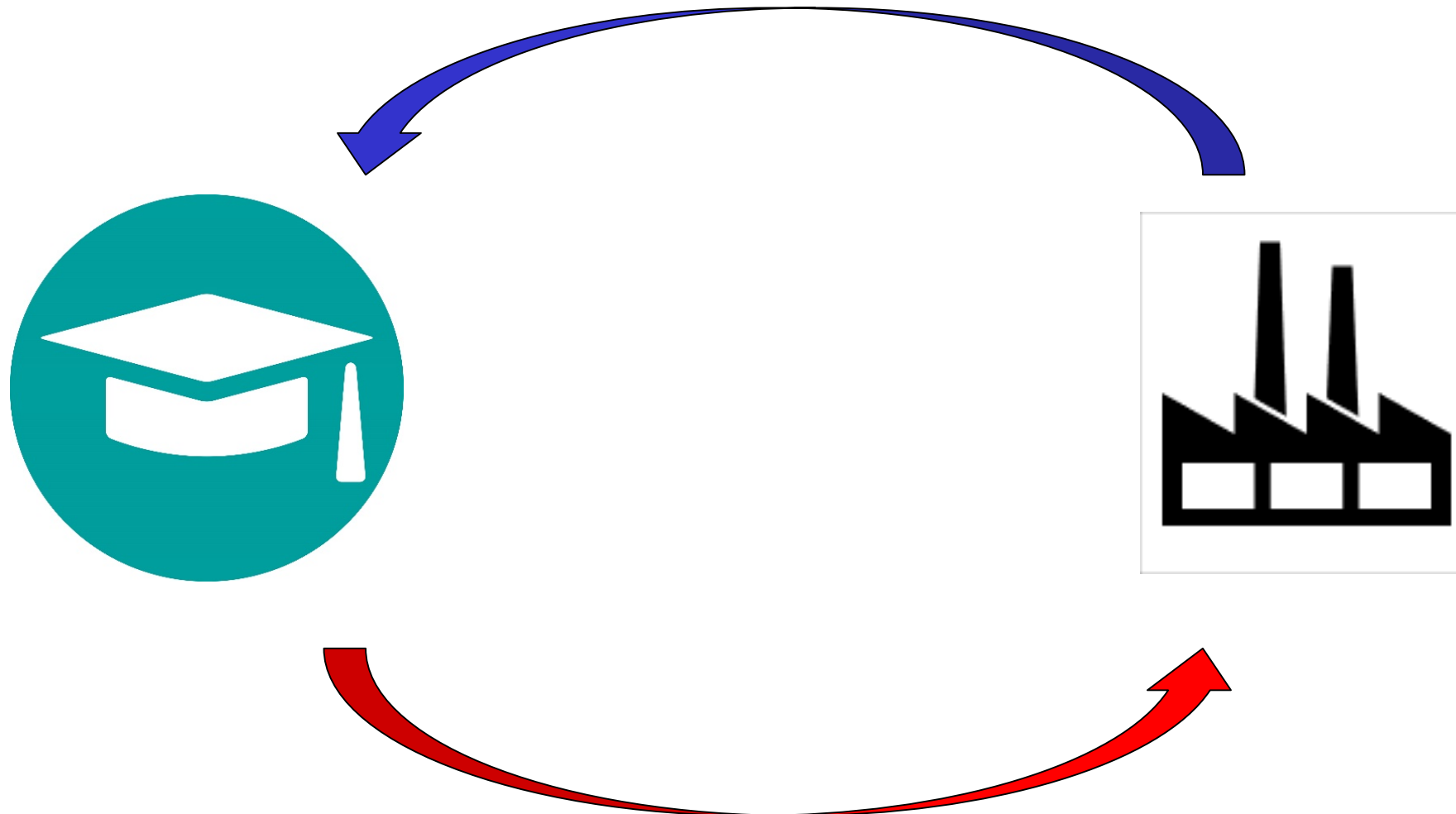
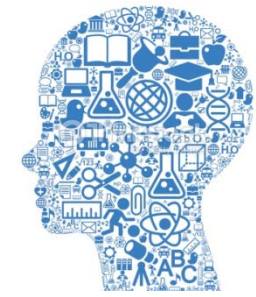
## Future Mining – Variety of influences



**Education**



## Trandisciplinary cooperation





# Glückauf

