

Mining-induced ground deformations in Kiruna and Malmberget

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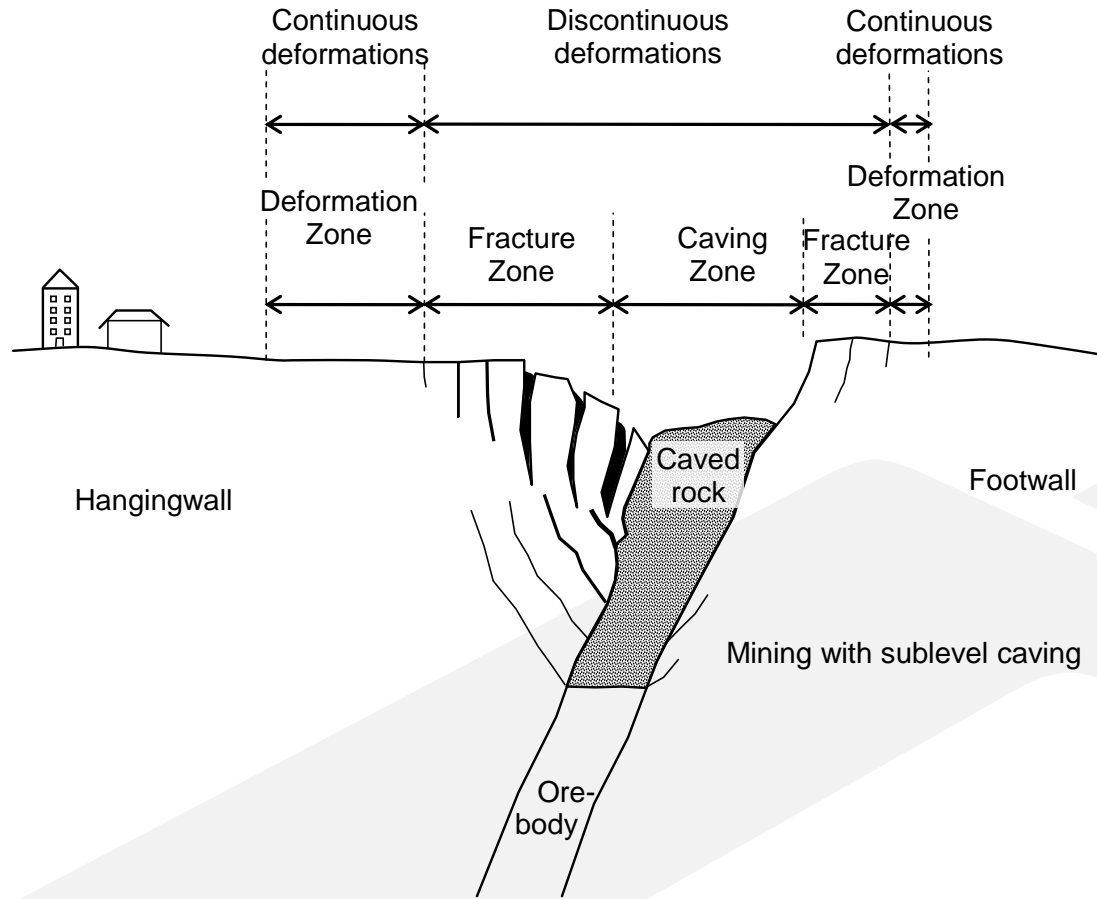
Kiruna year 1920...



...and 85 years later



Mining-induced ground deformations in sublevel caving



Impact on infrastructure

- Railroad
 - New railroad has been constructed and is open for traffic.
- Residential buildings
 - First "move-out" in 2014 ("Ullspiran" apartment complex)
 - Others to follow...
- Other buildings
 - The LKAB company hotel ("Bolagshotellet") in 2015
 - "Hjalmar Lundbohmsgården" (the former residence of the founder of LKAB) in 2015
- The bridge – mine access road (2013)
- The City Hall, The Fire Brigade, etc (2017...)

Kiruna - view towards north



Monitoring of ground deformations

- GPS Measurements

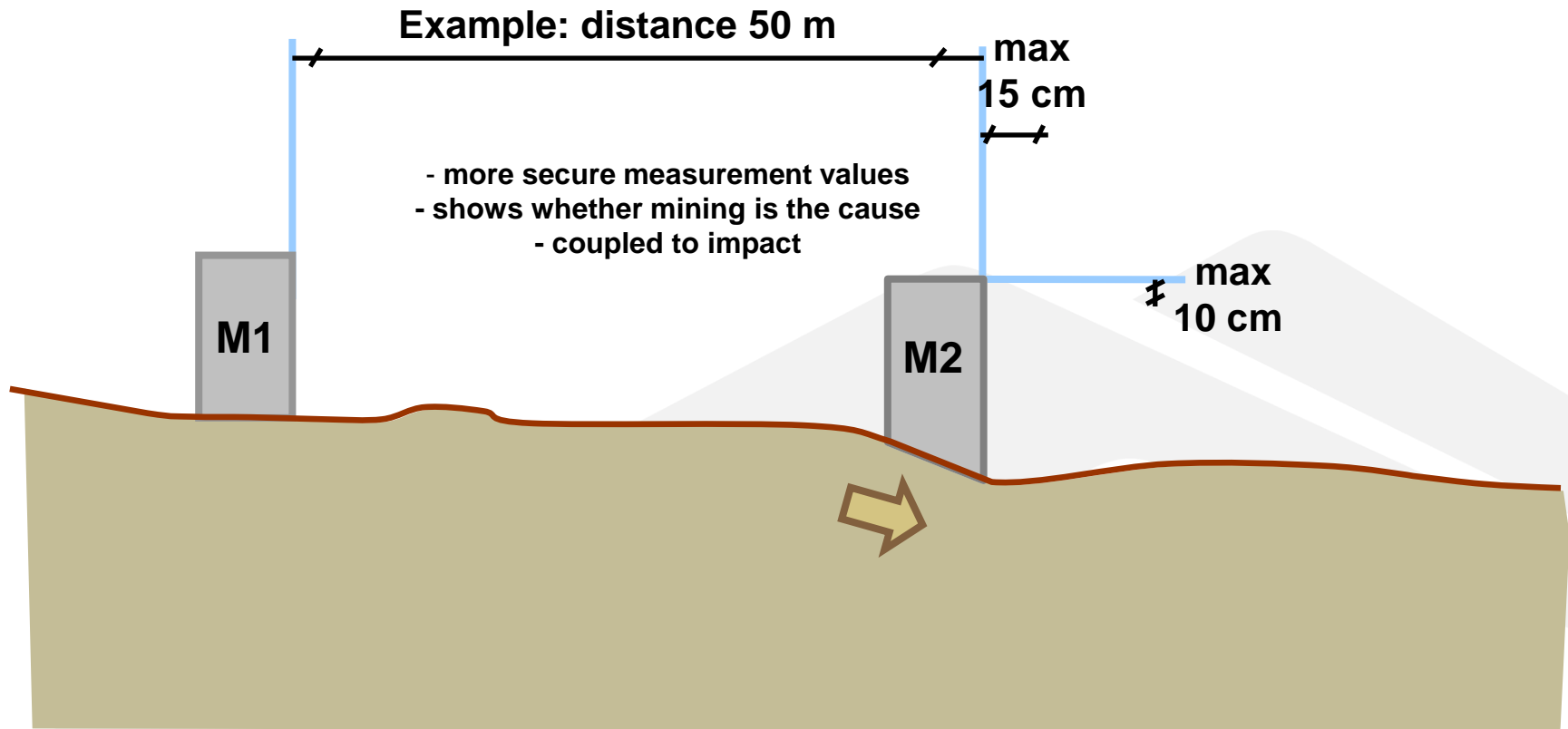


- Measurement since 2003 (total station from 1996)
- 337 measurement hubs
- Measurement of deformations in horizontal and vertical direction
- All points measured annually; selected points measured each quarter
- Reporting internally and externally each quarter:
 - "Environmental criteria" – differential movement per ruling in the Swedish Environmental Court = limit for LKAB industrial area

Maximum allowed ground deformation

Limit for allowed deformations

Strain limit – 0.3 % horizontally, 0.2 % vertically



Monitoring results September 2012



Prognosis of ground deformations

- Prognosis of location of "environmental criterion" limit for the years:
 - 2013
 - 2018
 - 2023



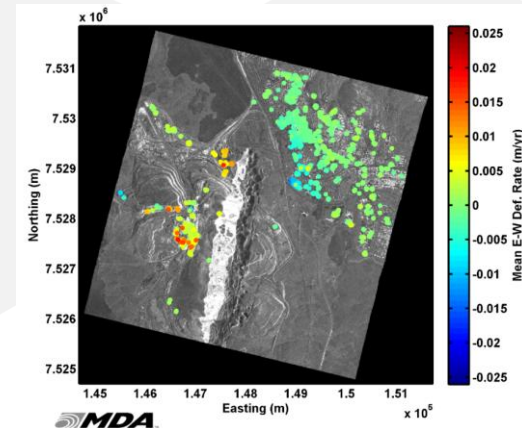
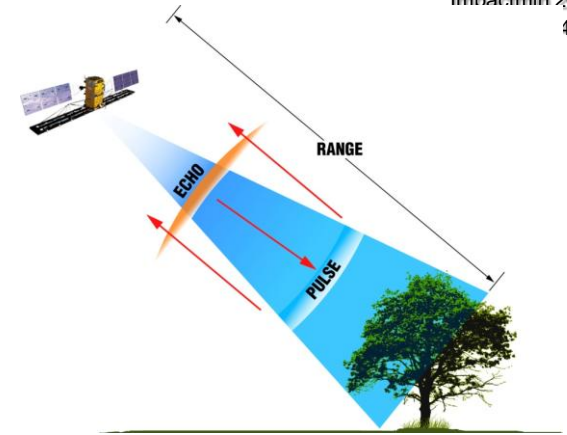
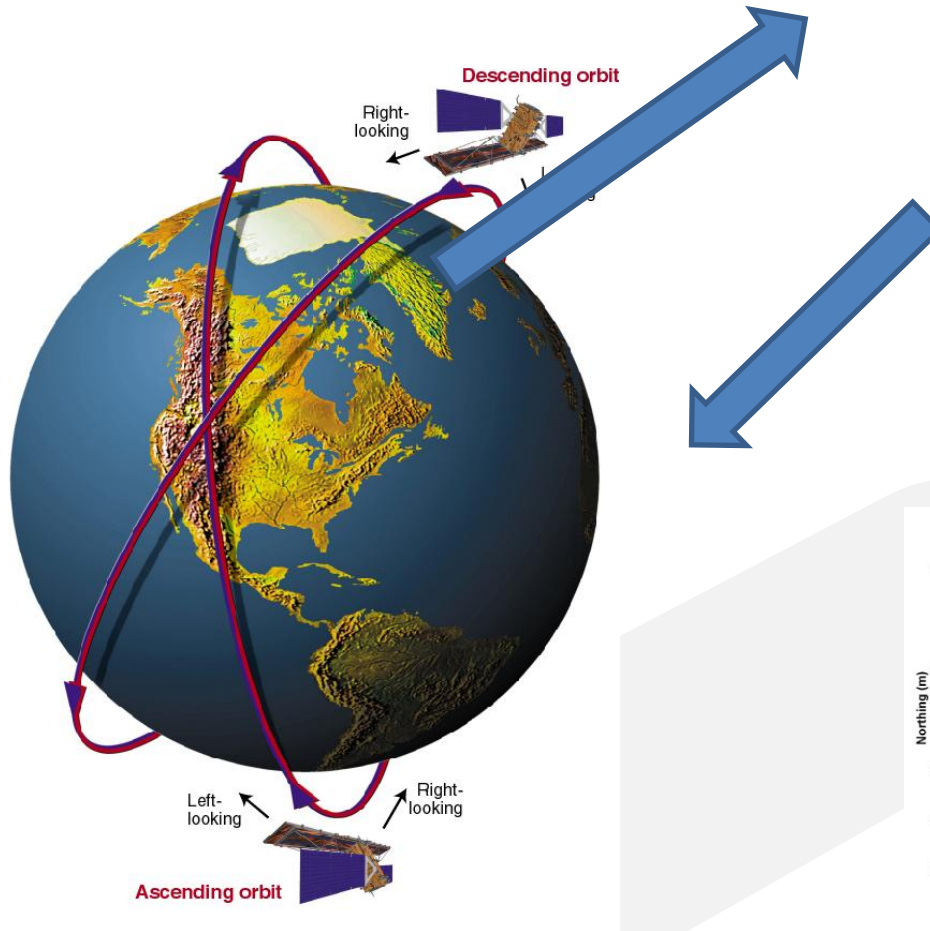
DEFORMATIONS IN THE NORTH PART OF THE MINE



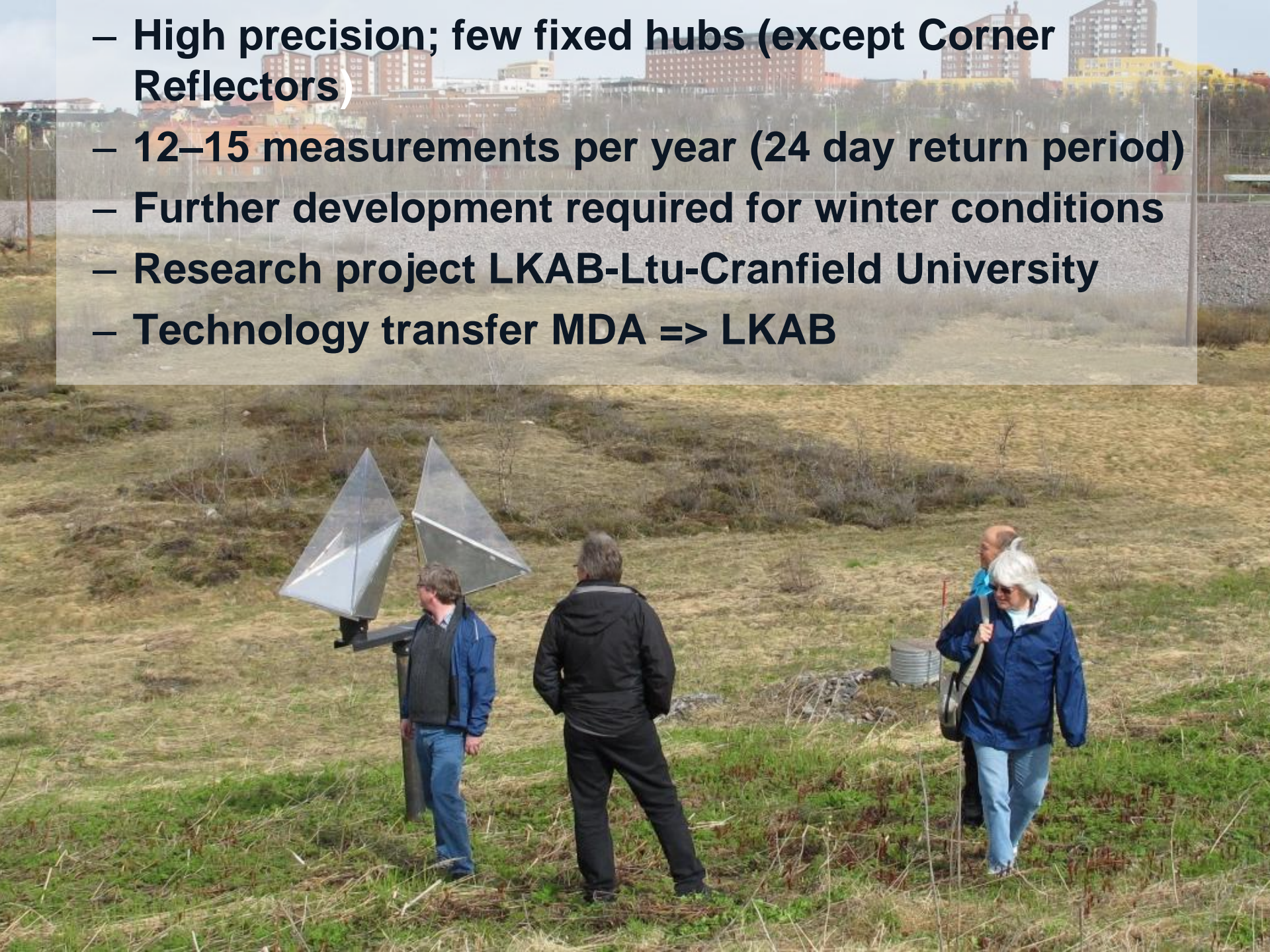
Developments and Future Work

- Improved deformation monitoring
 - Extended GPS network
 - InSAR-project
- Improved prognosis & precision
 - Annually review and revision (if required) of prognosis
 - PhD-project at Luleå University (Ltu)

The InSAR-project



- High precision; few fixed hubs (except Corner Reflectors)
- 12–15 measurements per year (24 day return period)
- Further development required for winter conditions
- Research project LKAB-Ltu-Cranfield University
- Technology transfer MDA => LKAB



Thanks!

