TGP GEOHAZARD PREVENTION SYSTEM WITH COMMUNICATION OPTICAL FIBER CABLES: A FULL-SCALE CASE STUDY

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Outline

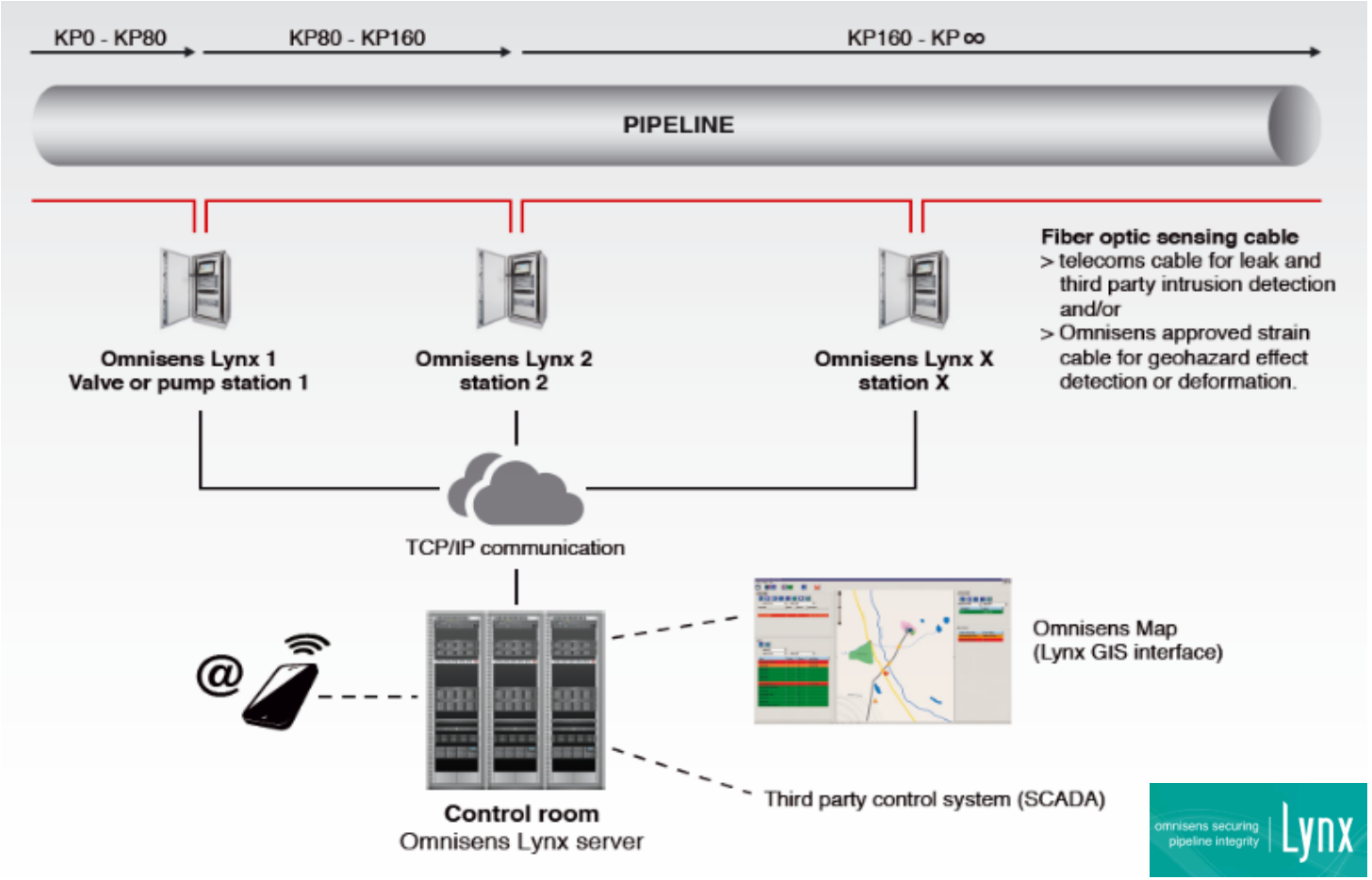
- Introduction
  - The TGP transport system case and its exposure to natural hazards
- The Geotechnical Monitoring System (GTMS)
  - Sensing technology and natural hazards
- Example
- Conclusions

Introduction

Complete Transport System and Area of Focus

- TGP is the owner/operator of a large transport System
  - NG and NGL
  - 730 km from the Jungle to the Coast
  - Crossing the Andes
- Exposure to natural hazards
  - Selva, Selva Alta, Sierra Sections
    - Landslides and hydraulic erosion
  - Sand dune section
    - Eolian erosion
- Optical fiber cable laid for SCADA
  - Optical fiber can also be used for sensing strain, temperature and vibrations
  - Proposal to use it for natural hazard detection

Geotechnical Monitoring System (GTMS)



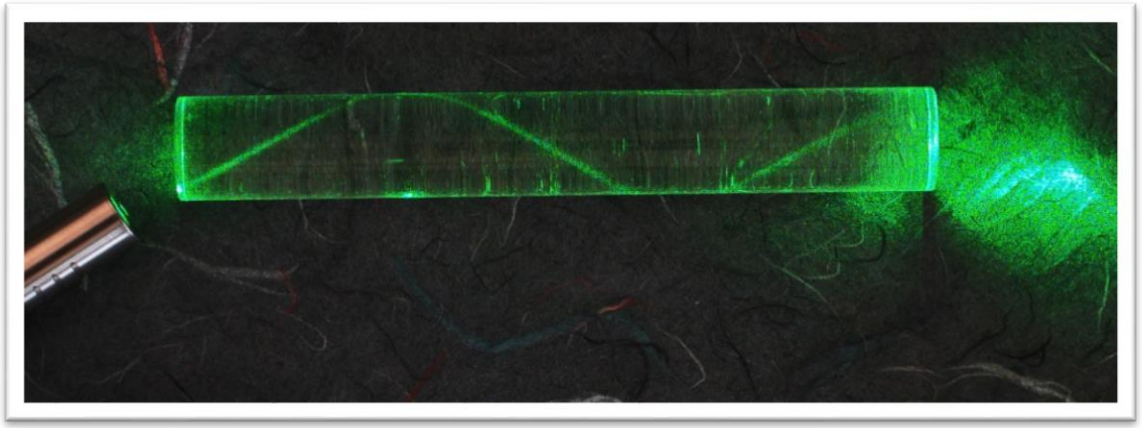
- GTMS part of comprehensive monitoring system
  - GTMS is a component with focus on natural hazard monitoring
  - Leak and third party intrusion par of the complete system
- GTMS requires and offers
  - Optical fiber cables
  - Communication between stations
  - Display in GIS
  - Centralized data analysis and storage
  - Distributed sensing technology
    - Strain and temperature sensing with capability of localization
    - Vibration sensing

Distributed Sensing – The Concept

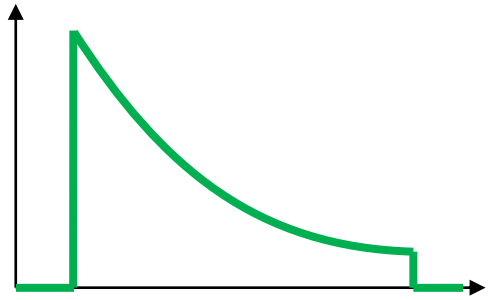
- Turning optical fibers into a fully distributed sensor

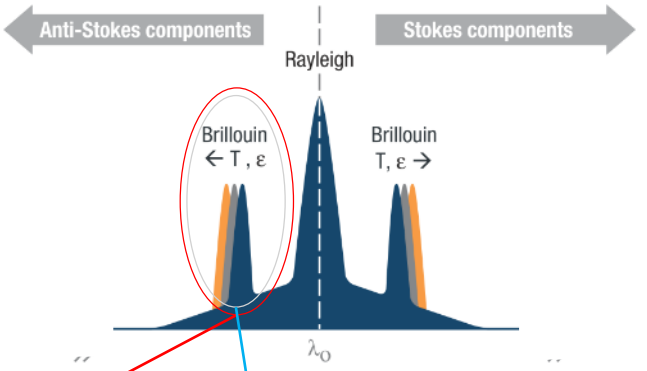
Optical Fiber Distributed Sensing

- Distributed sensing uses light scattering
- Scattering originates from inhomogeneities in silica

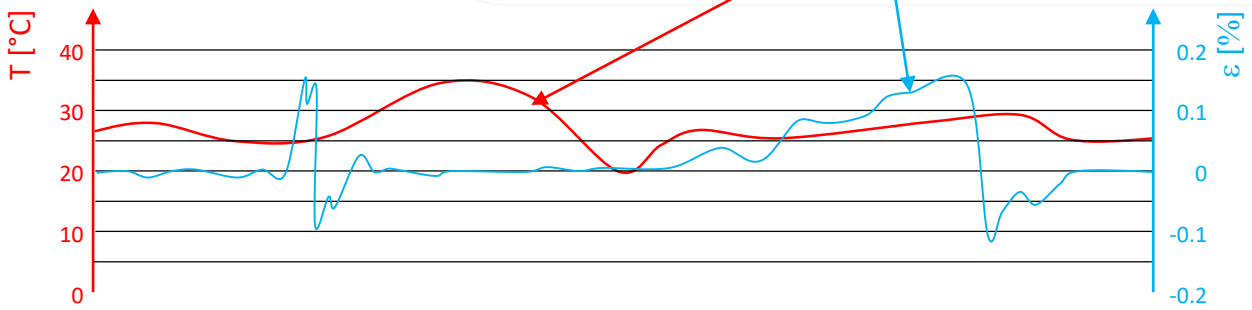


Optical Fiber Distributed Sensing





Distributed Temperature Sensing - DTS



Distributed Strain Sensing - DSS

Geohazard Detection, localisation and Monitoring

Geohazard	Soil Strain Measurement - DSS	Soil Temperature Measurement - DTS
Erosion		X
Subsidence	X	
Landslide	X	

Measured with Communication Optical Fiber Cable

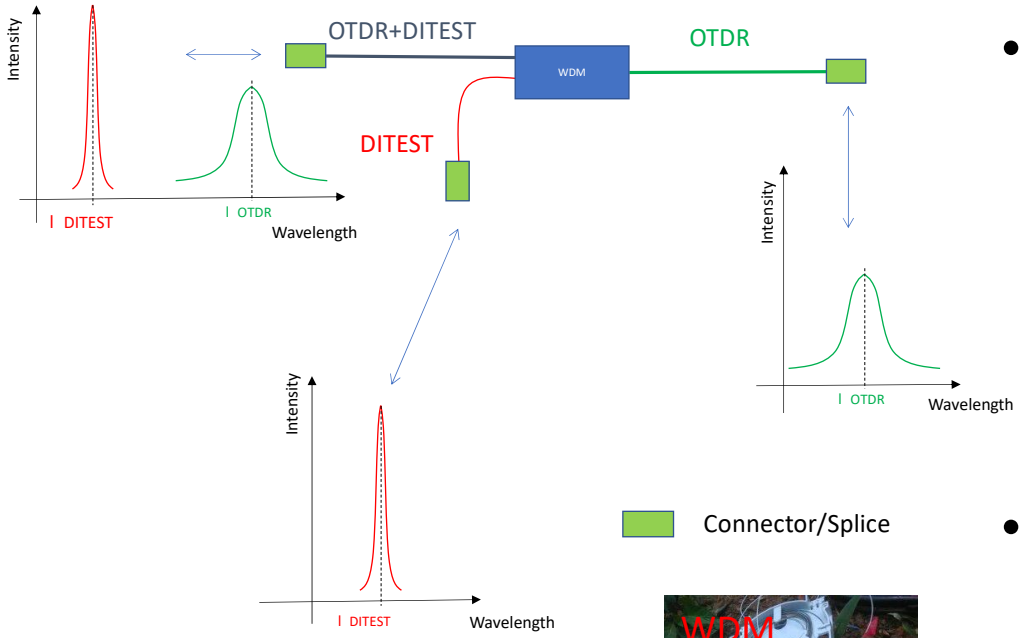
Measured with strain sensing cable, or with communication cable but with lower sensitivity

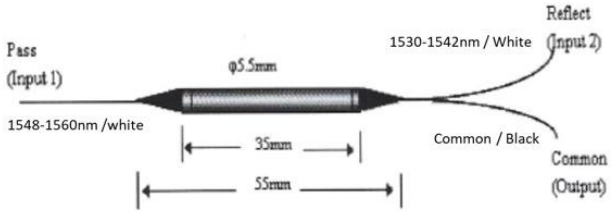
- What can we expect if one wants to use the communication cable to monitor strain?

Project Implementation advantages and Challenges

- Approach advantage
  - Use of exisiting fiber infrastructure and only need for interogators
  - Eventually retrofit critical sections with strain monitoring cable (SMC) whenever rehabilitation works have to be completed
- Monitoring requirement
  - One pair of optical fibers
- Challenges
  - Fiber disponibility limited
    - TGP communication and SCADA, field communication, fiber integrity application (automated OTDR)
  - High losses caused by numerous splicing and stresses on the cable (landslides etc)

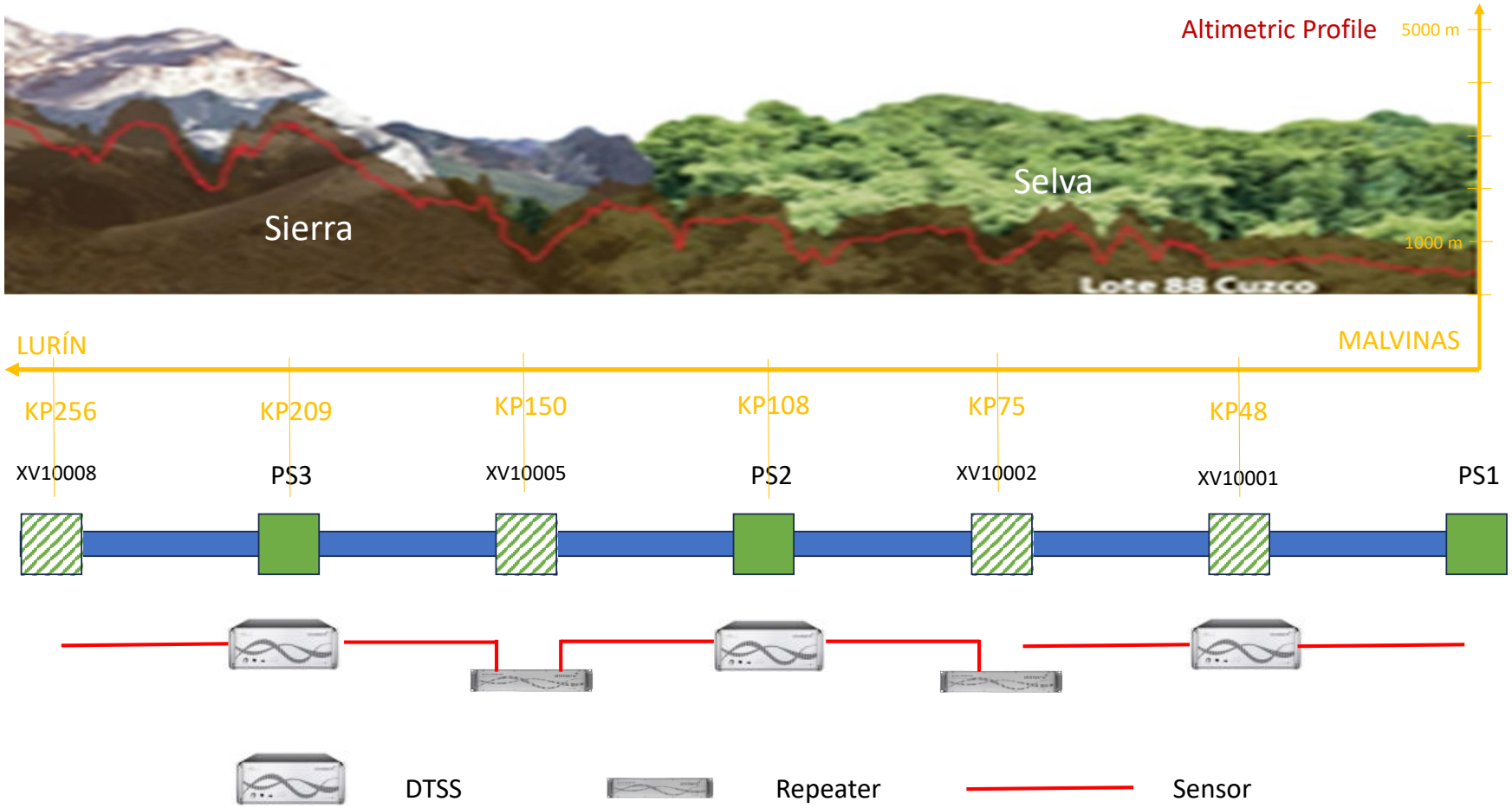
Responses to the challenges: Advancced Optical Fiber Technology





- Fiber disponibility issue resolved by the introduction of Wavelength Division Multiplexing (WDM)
  - Mixing of signals that are not at the same wavelength
  - Small form factor and power requirement
  - Installation in junction box, burried in the field or/and Optical Distribution Frames in Pumping Station and/or Valve Stations
- Fiber excessive loss issue resolved by using optical amplification
  - Installation in Pumping Stations or Valve Stations

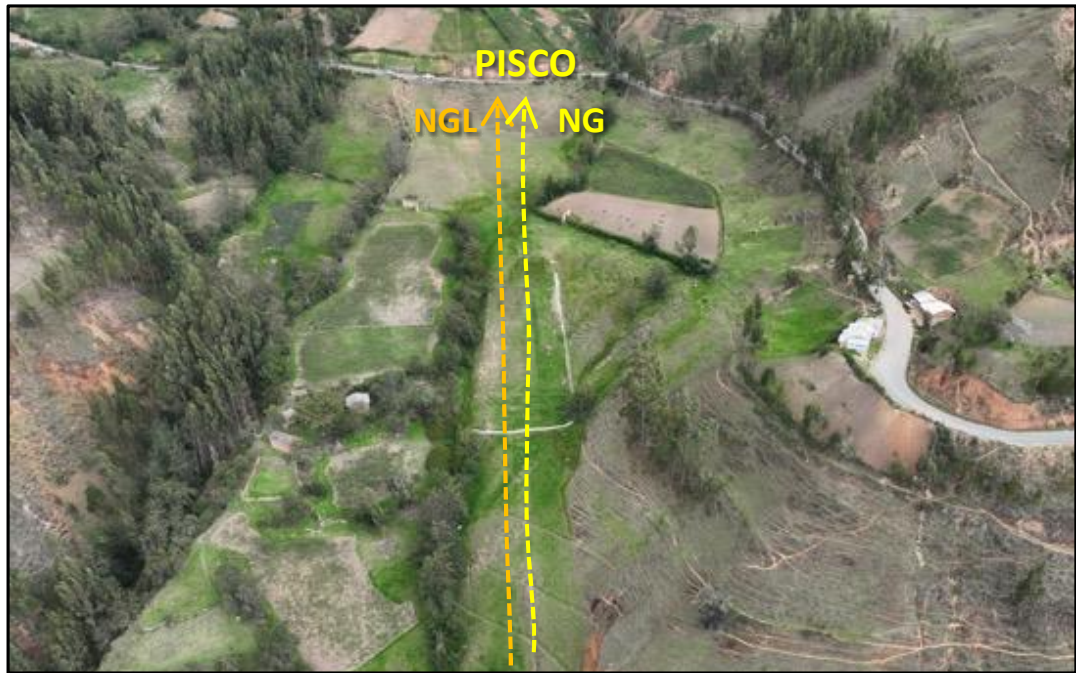
Monitoring Solution Implemented

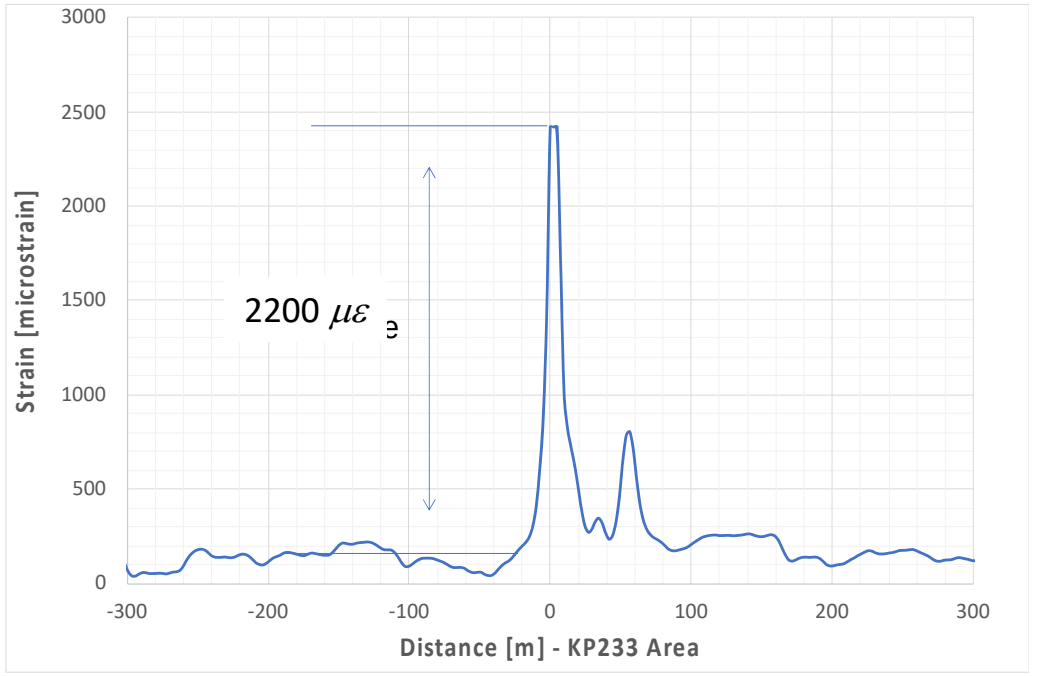


Commissioned completed early 2023

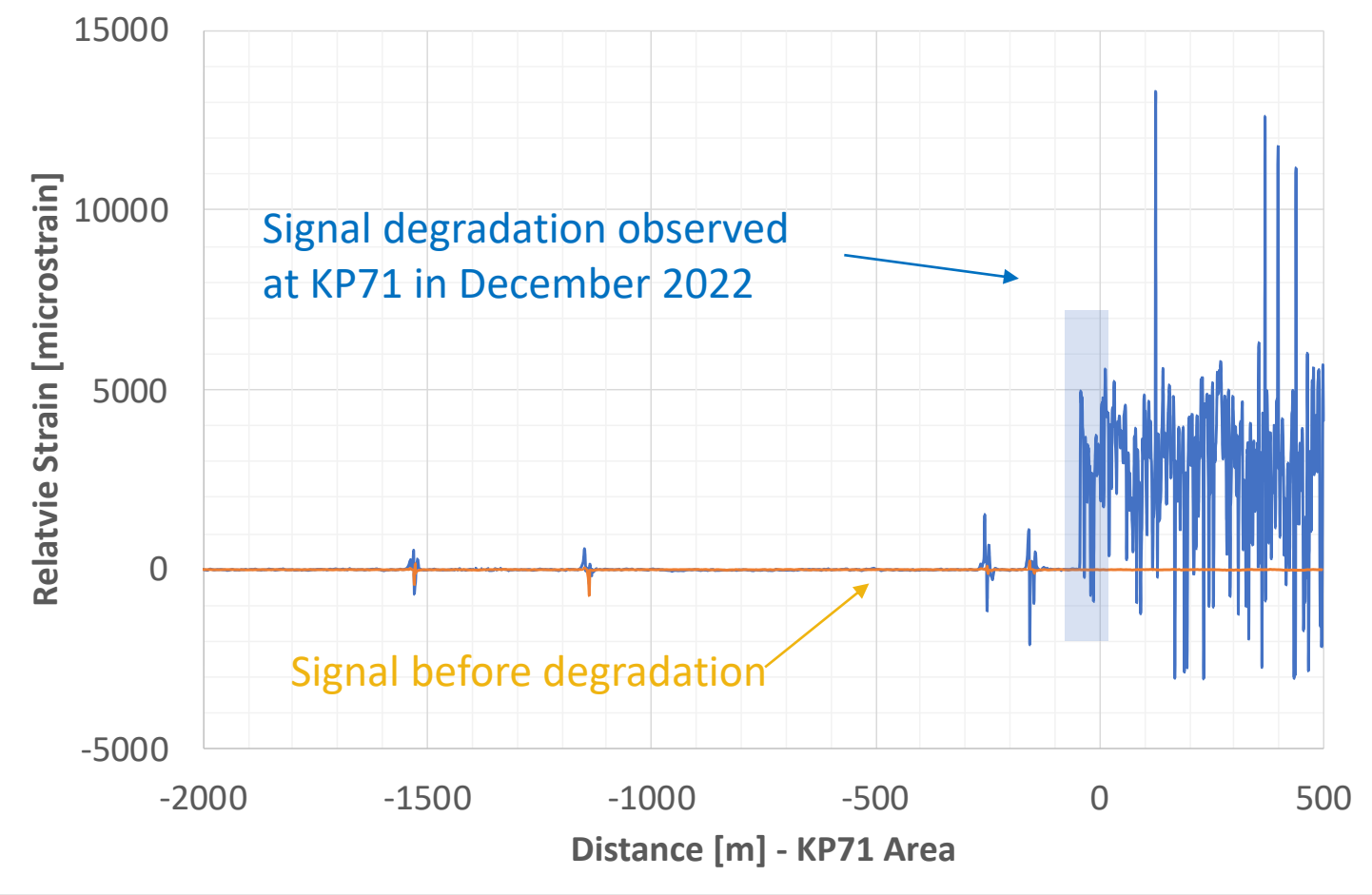
Event Detected in Sierra Region

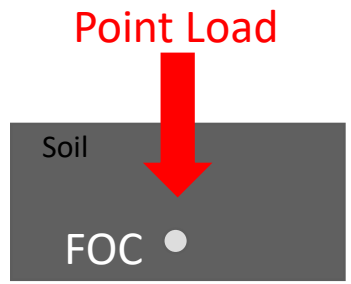
- Observation during commissioning (December 2023)
- Event of 2200 $\mu\varepsilon$, associated with a geotechnical finding





Event Detected of Constructive Origin in Selva Region





- Event observed during commissioning phase
- Local load crushes the cable
- Attenuation increase and signal degradation

Conclusion

- Retrofit of 256km of the natural gas transport system by using the communication cable
- Introduction of advanced optical fiber technologies common is high density and long distance communication systems
- System is unattended, provide realtime data and operates 24/7
- Environmental impact is low as one takes advantage of an existing infrastructure

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