



Everything is not what it seems: The importance of comprehensive geological assessments to understand ground instabilities identified by DInSAR

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Living Planet Symposium 2022

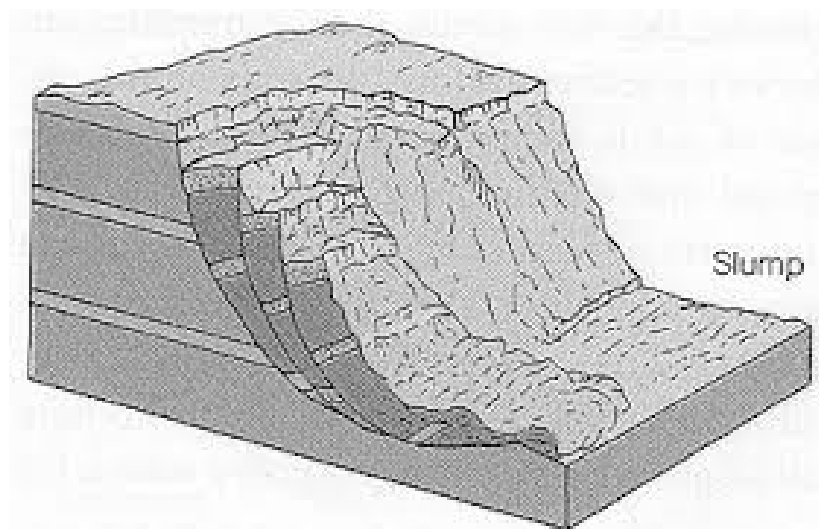


23-27 May 2022
Bonn, Germany

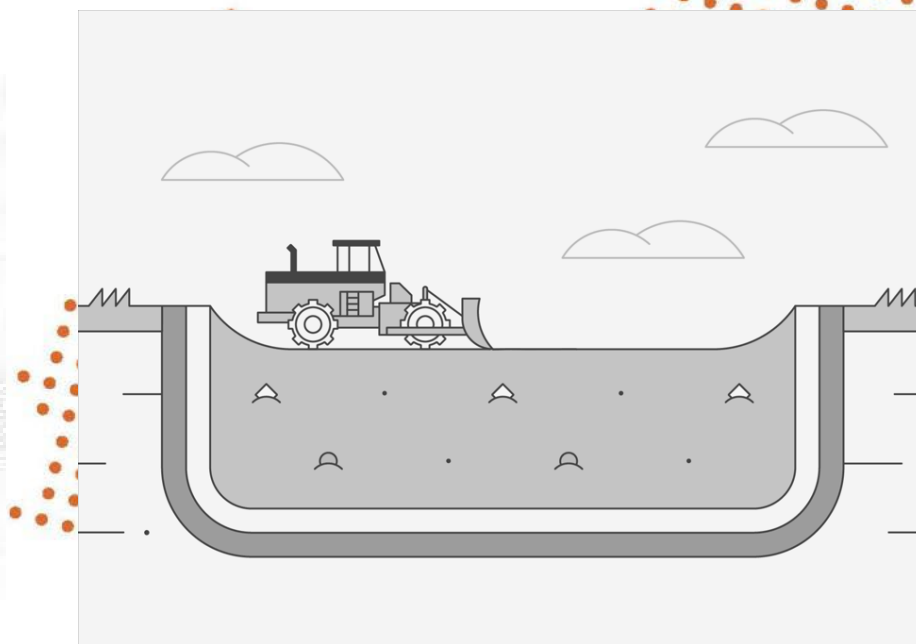


Common processes behind unstable ground detected by InSAR

Slope movements



Landfill compaction



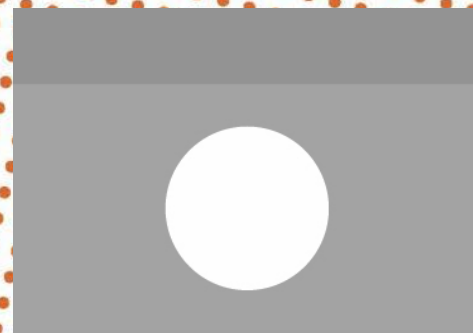
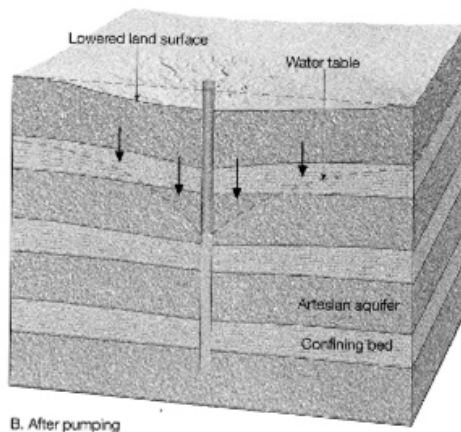
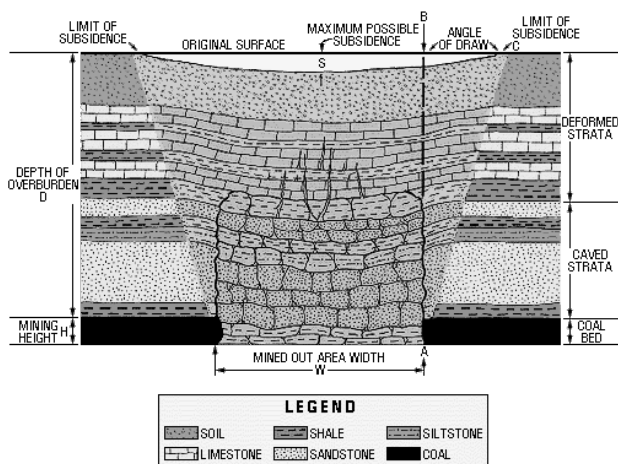
Common processes behind unstable ground detected by InSAR

Subsidence induced by

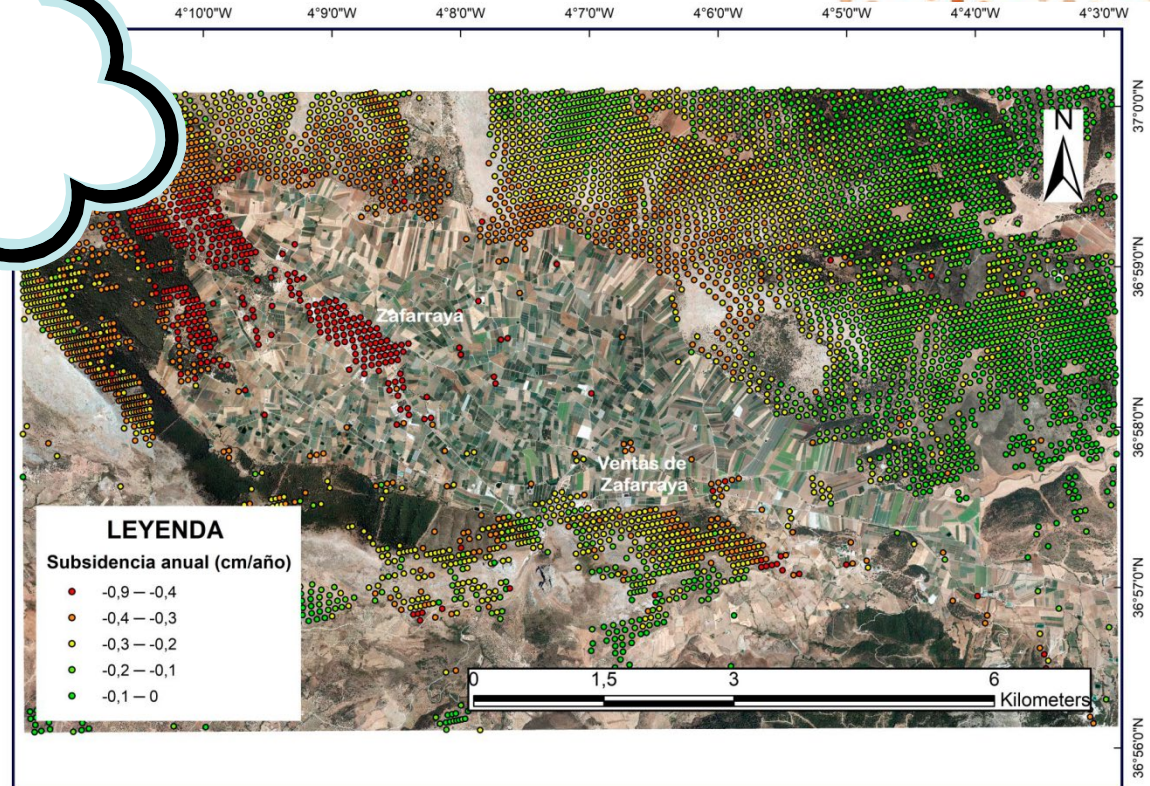
...mining

...fluid extraction

...rock dissolution



Sometimes everything is not what it seems in DInSAR results.



Case studies where the interpretation of ground movements was not straightforward

Zafarraya Polje (Granada, Spain)



Zafarraya Polje (Granada, Spain)

1. What is a polje?



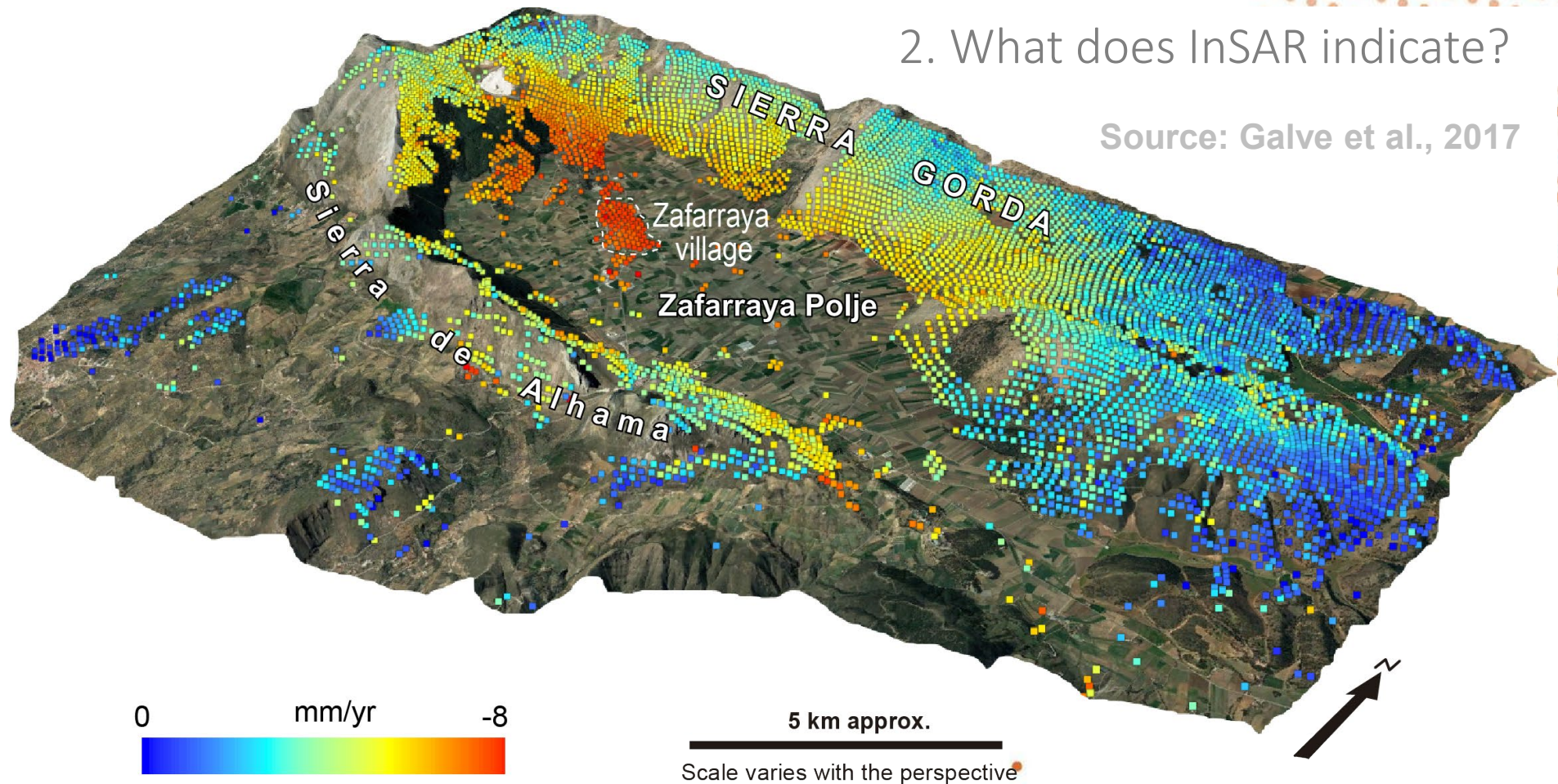
Source: Stepišnik et al., 2015



Zafarraya Polje (Granada, Spain)

2. What does InSAR indicate?

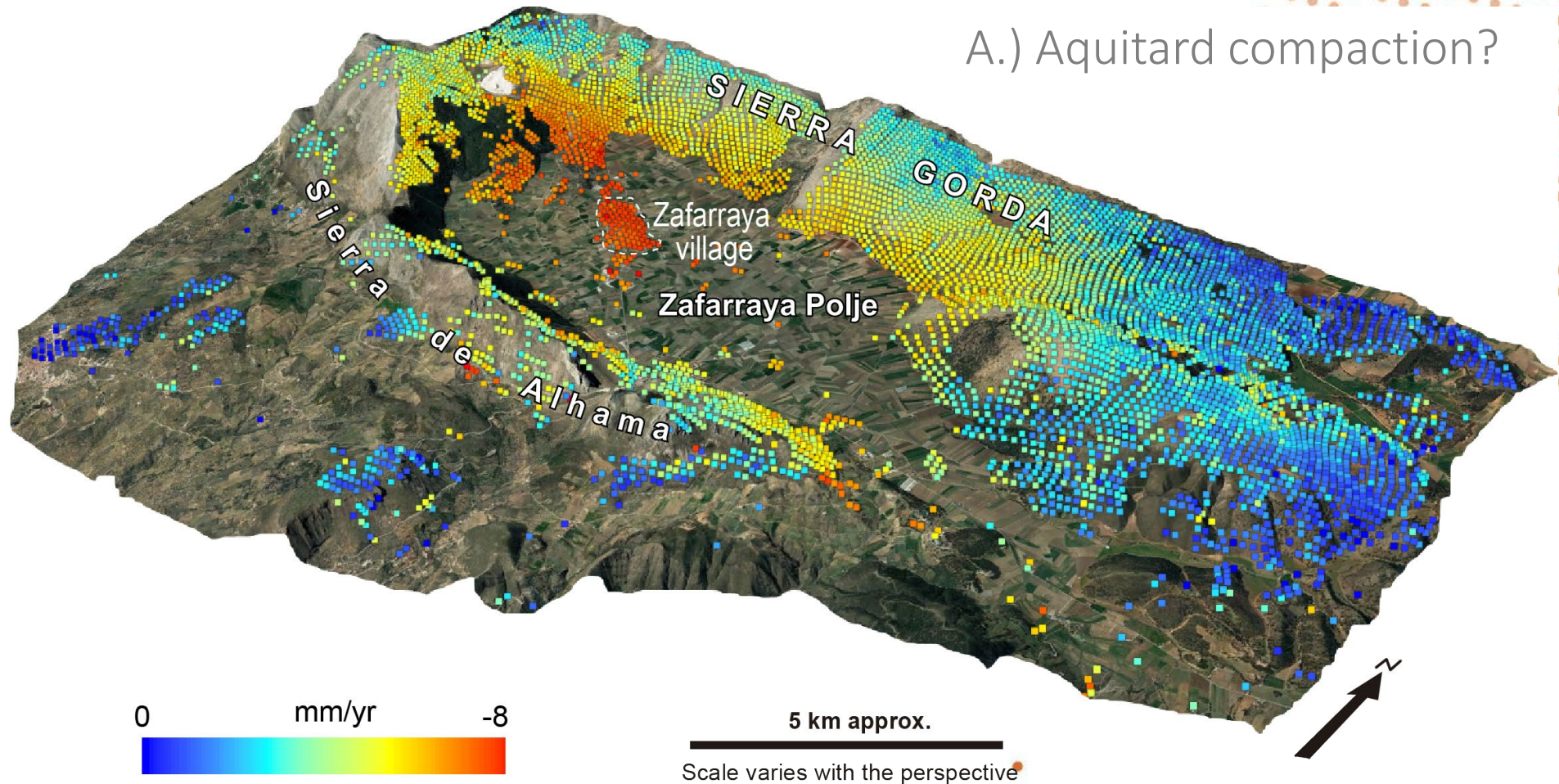
Source: Galve et al., 2017



Zafarraya Polje (Granada, Spain)

3. How deformation could be explained?

A.) Aquitard compaction?

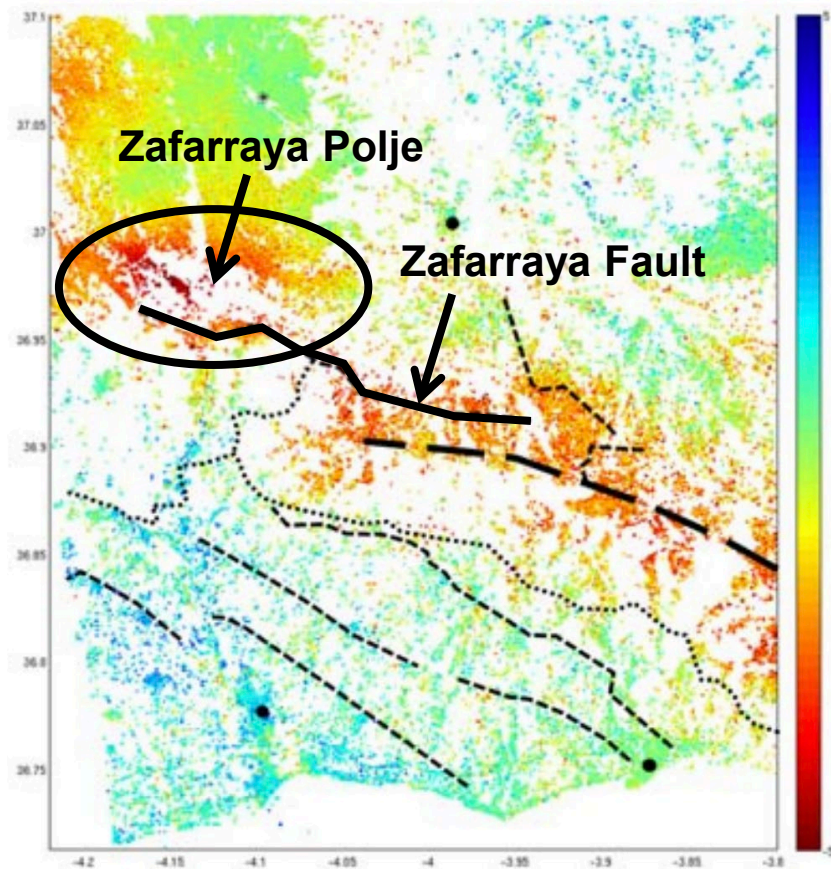
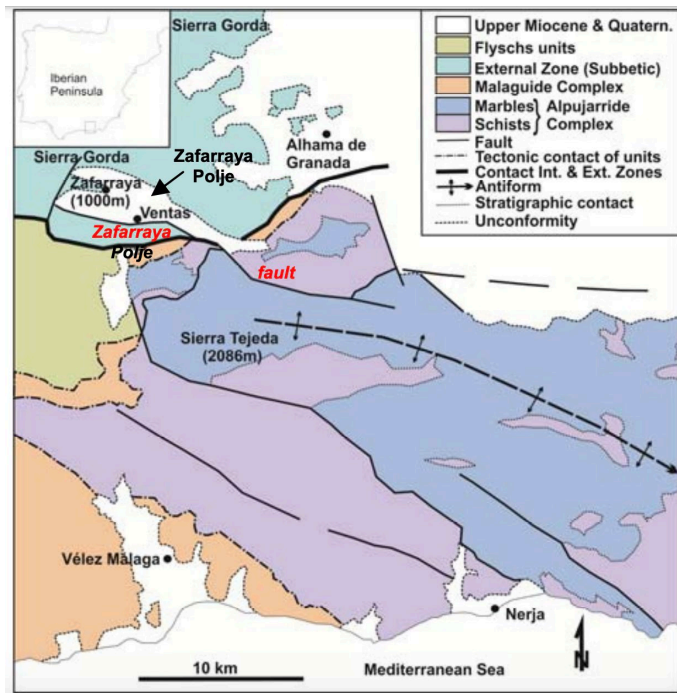


Zafarraya Polje (Granada, Spain)

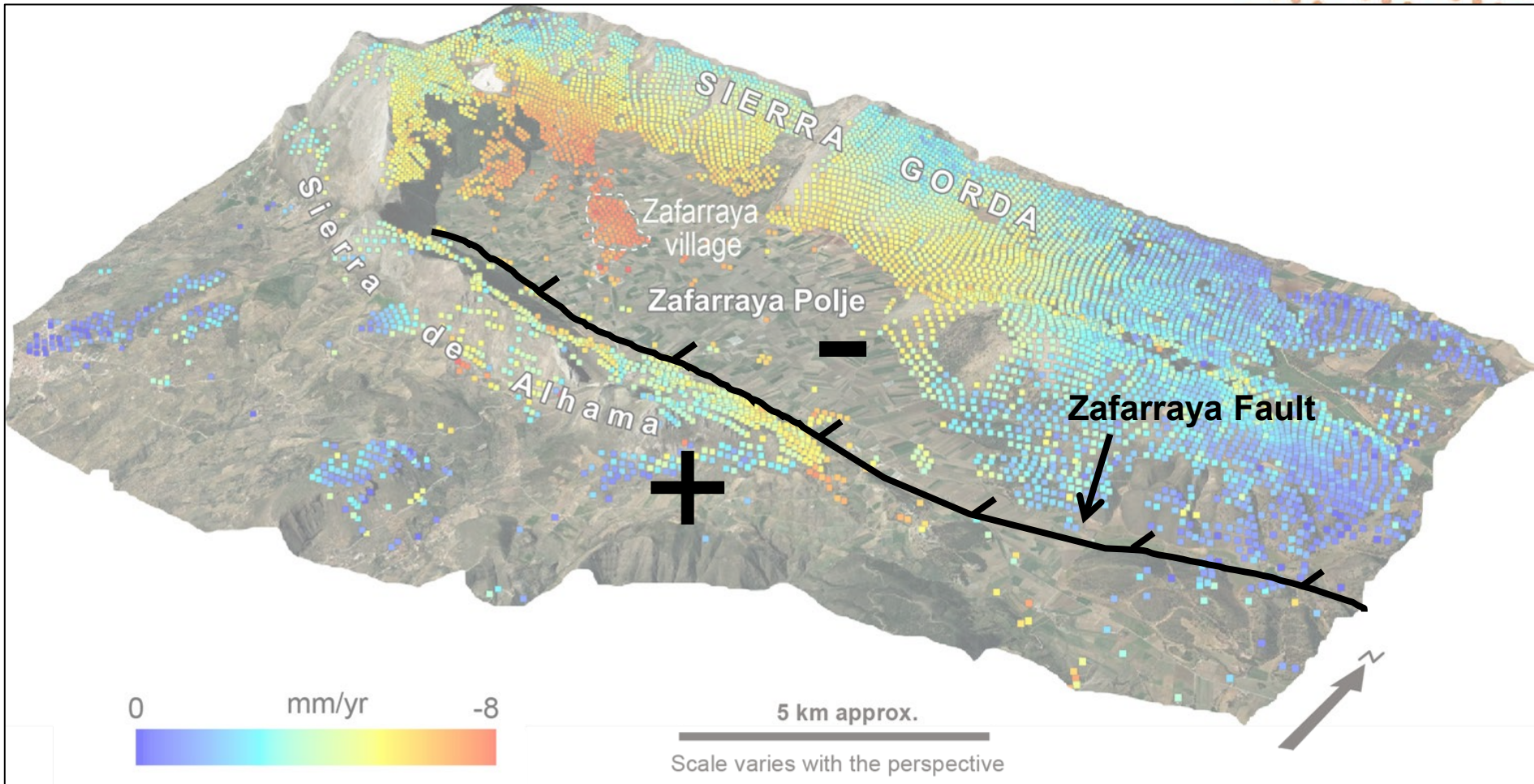
Source: Ruíz-Armenteros et al., 2015

3. How deformation could be explained?

B.) Active tectonics?

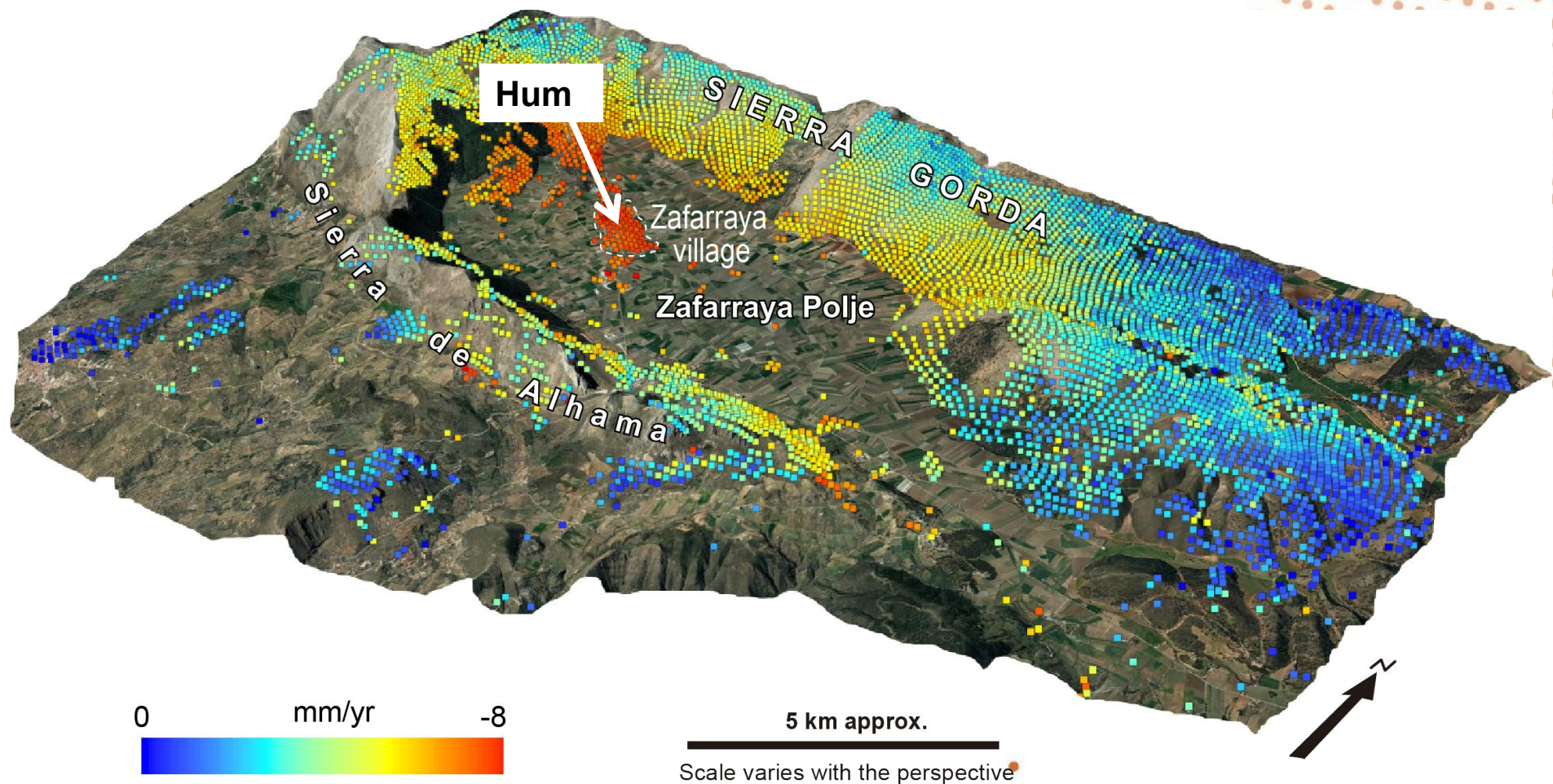


Zafarraya Polje (Granada, Spain)

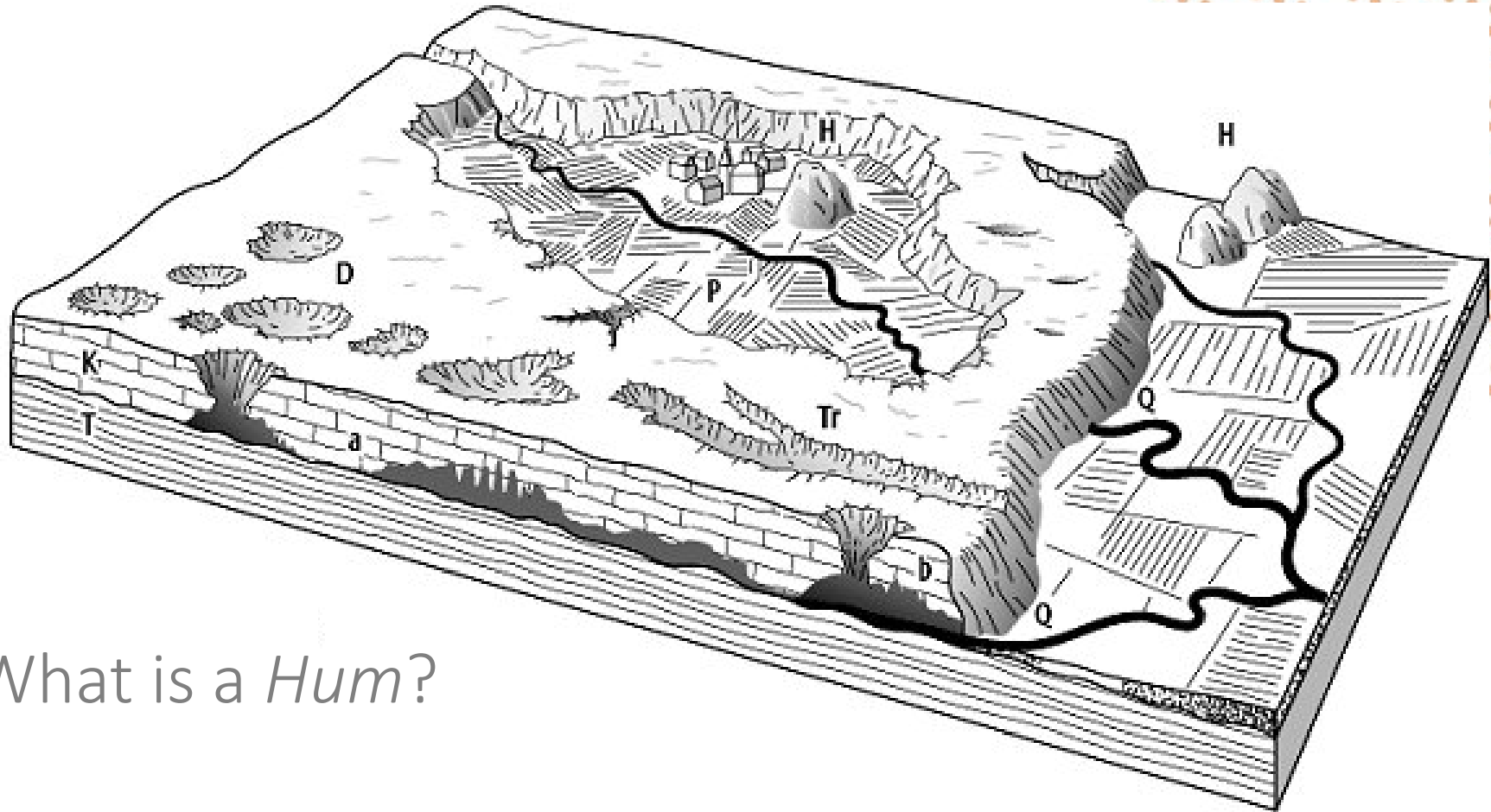


Zafarraya Polje (Granada, Spain)

3. How deformation could be explained?



Zafarraya Polje (Granada, Spain)

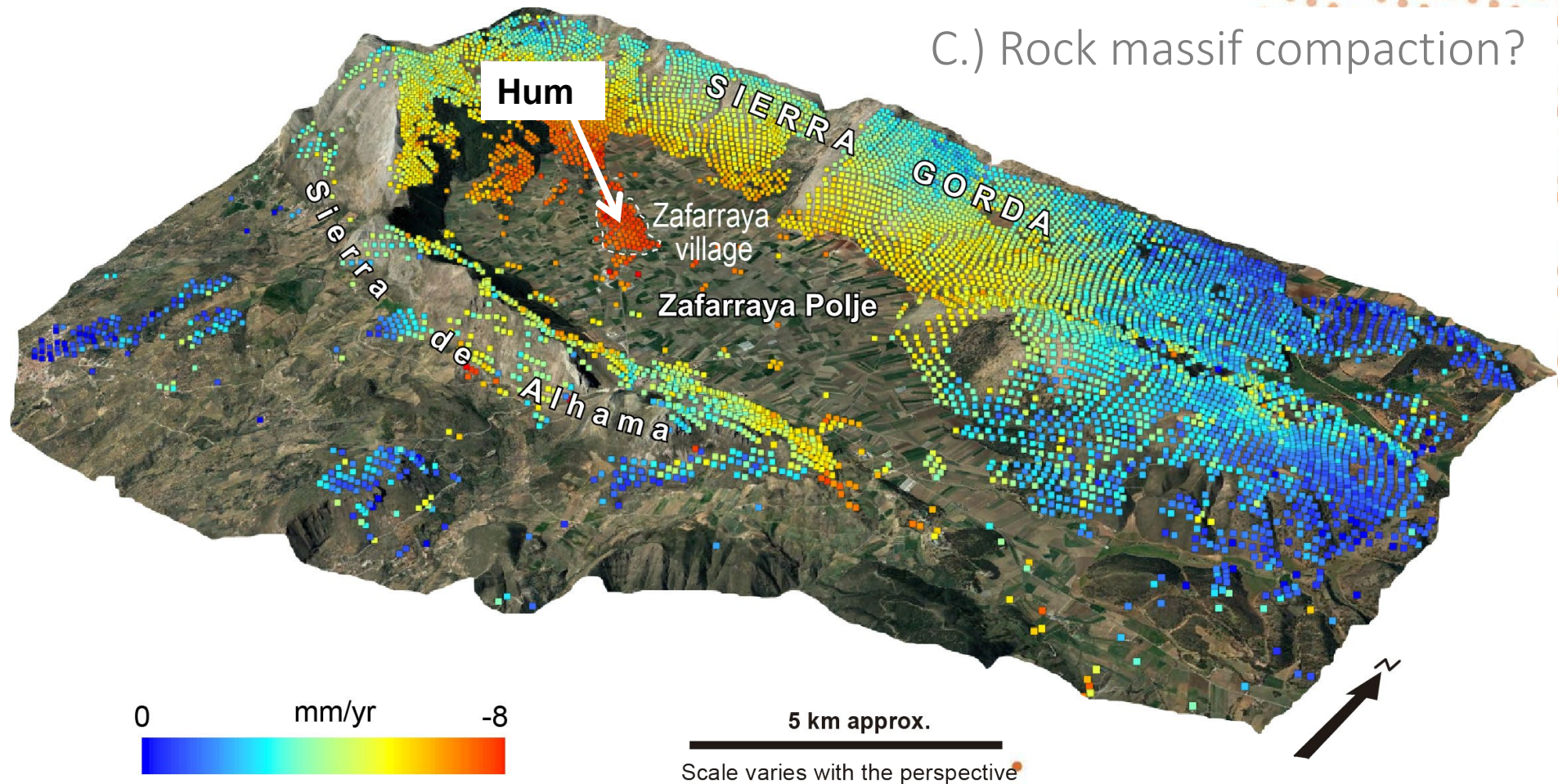


What is a *Hum*?

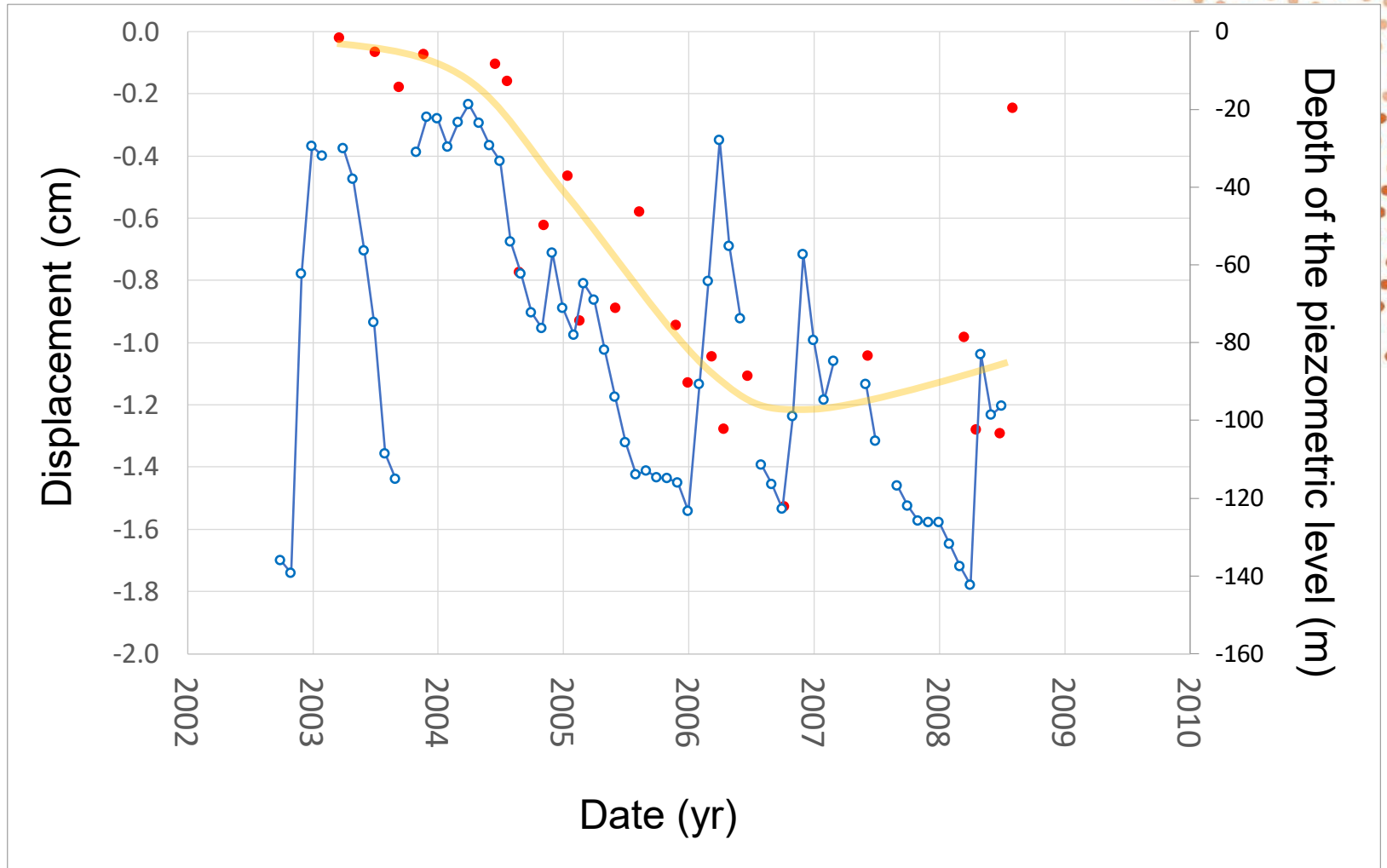
Zafarraya Polje (Granada, Spain)

3. How deformation could be explained?

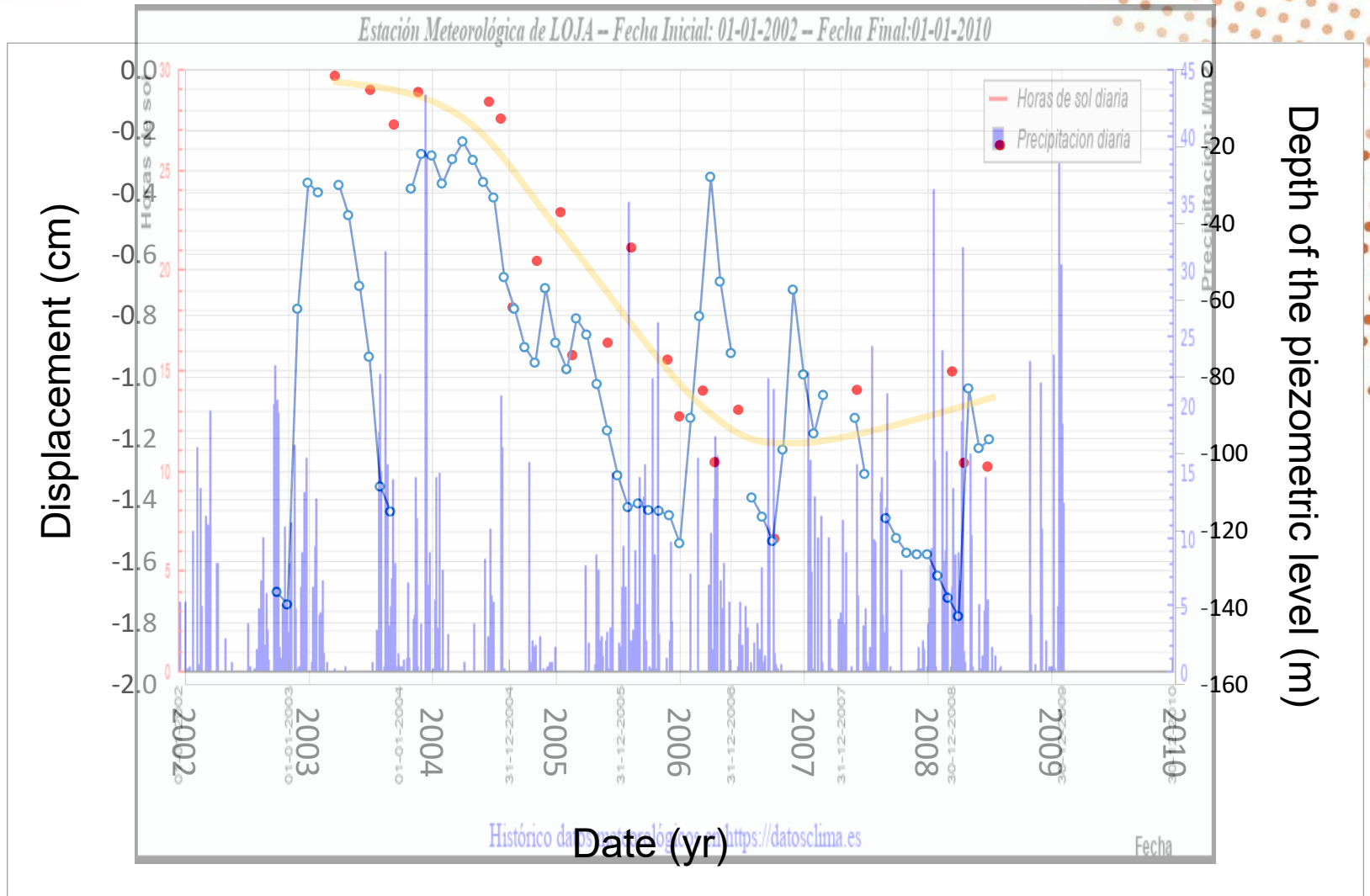
C.) Rock massif compaction?



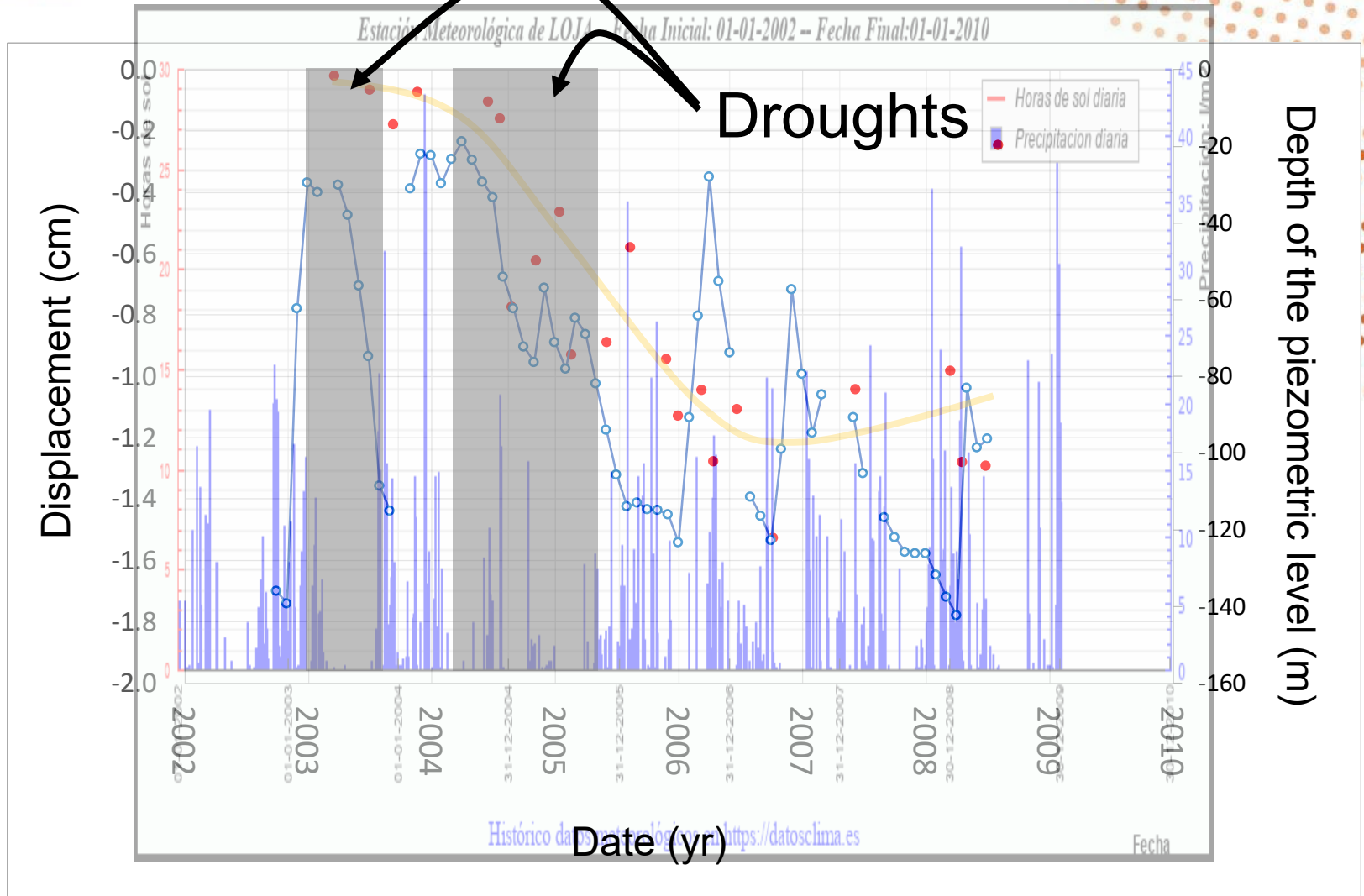
Polje of Zafarraya (Granada, Spain)



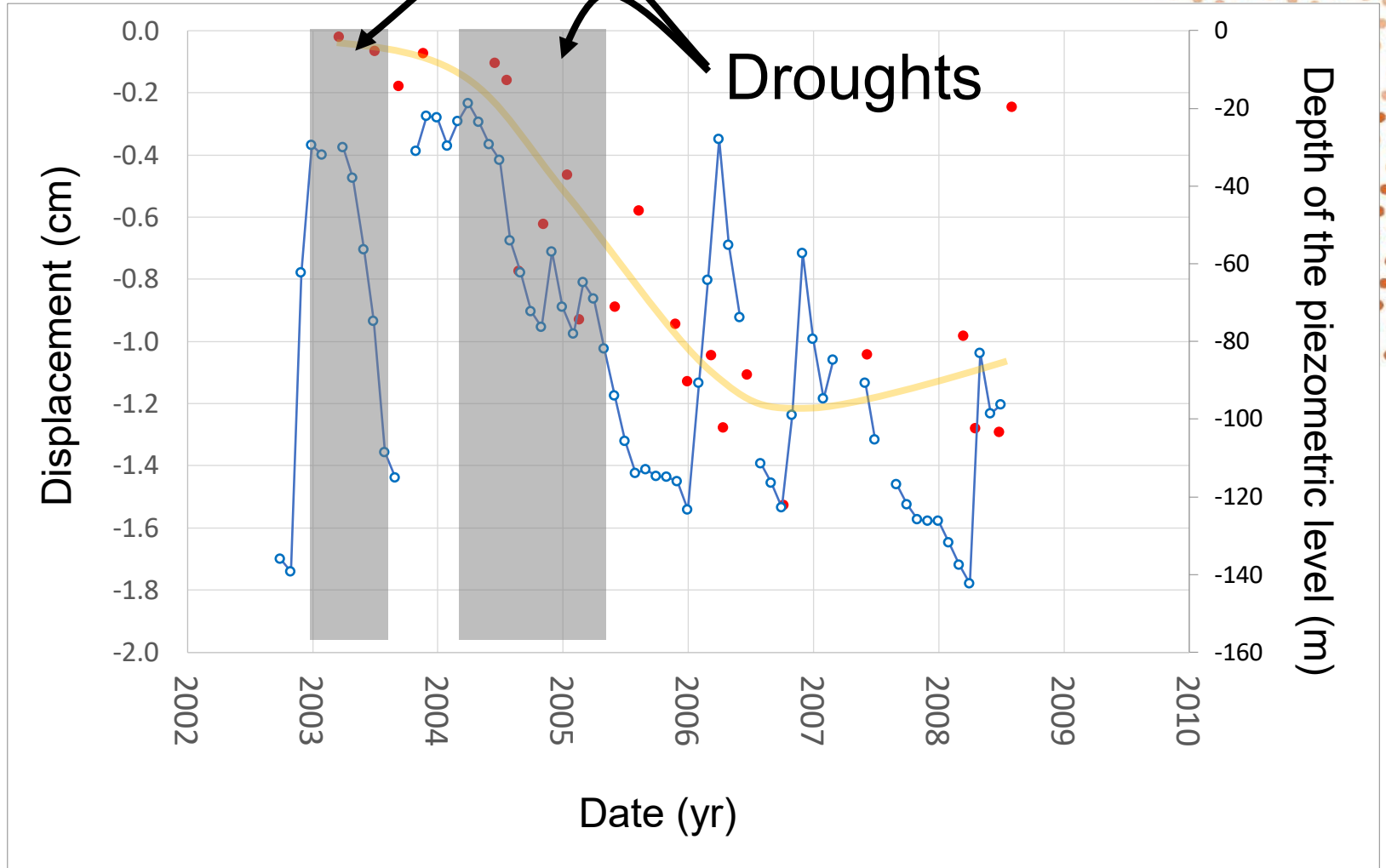
Polje of Zafarraya (Granada, Spain)



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Polje of Zafarraya (Granada, Spain)



Polje of Zafarraya (Granada, Spain)



Summary:

- Subsidence detected **only in the 2003-2008 period** (Envisat)
- Subsidence is not detected with ERS & Sentinel-1
- Subsidence coincide with the sharp drop in the piezometric levels of the karstic aquifer due to **groundwater withdrawal** caused, in turn, by a intense **drought period**.
- There are not so intense droughts in the periods covered by ERS and Sentinel-1 images (1992-2000; 2014-2022).



Knowledge needed to interpret InSAR results in Zafarraya

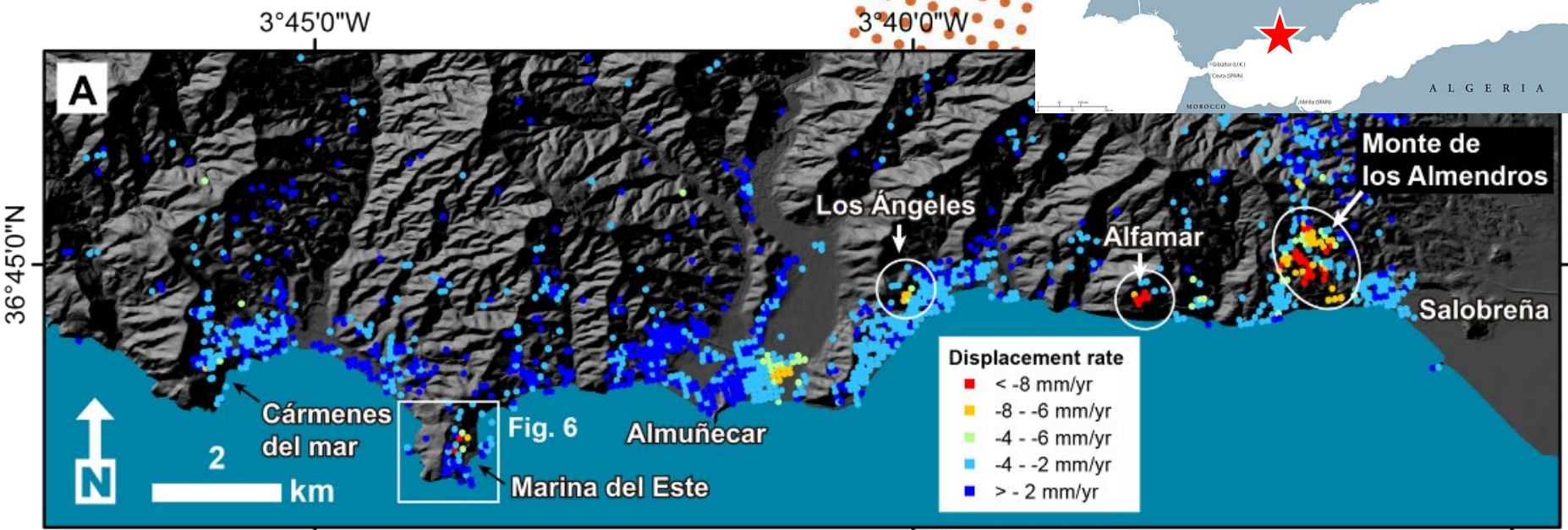
- Reliability of the DInSAR results
- Karst Geomorphology
- Active Tectonics
- Hydrogeology
- Subsidence processes
 - Aquitard compaction
 - Rock massif compaction

Geodynamics

Case studies where the interpretation of ground movements was not straightforward

Monte Almendros Urban Estate (Granada, Spain)

Source: Galve et al. 2017

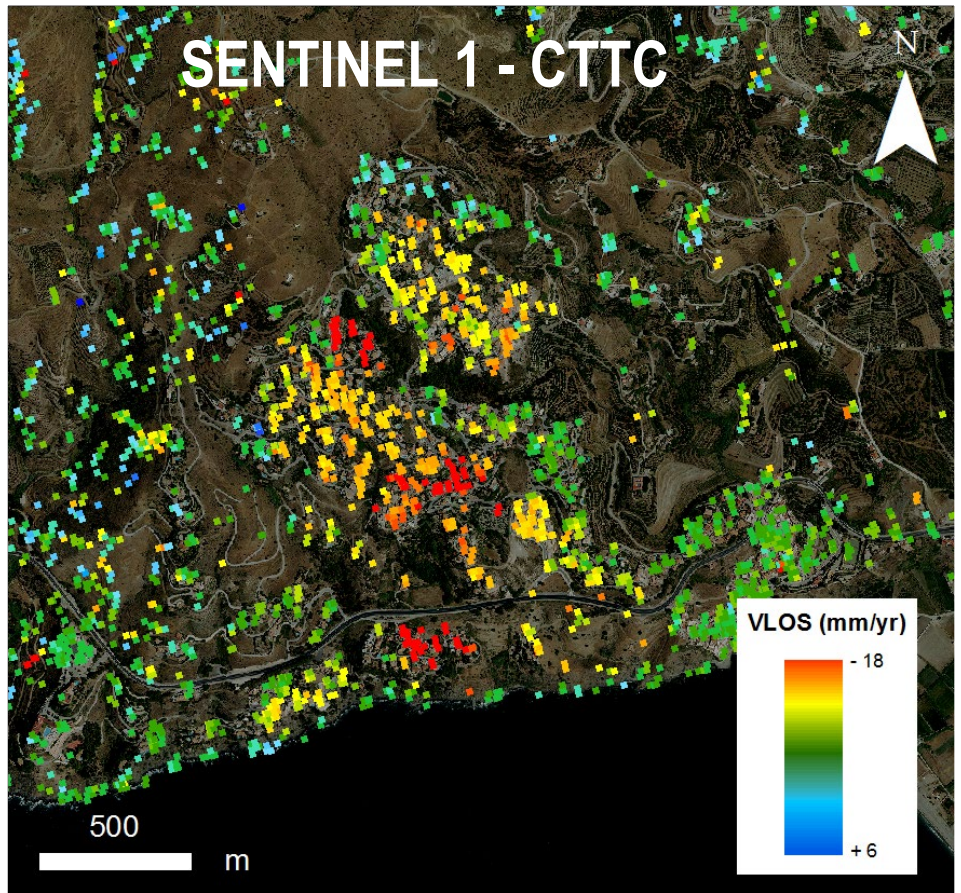
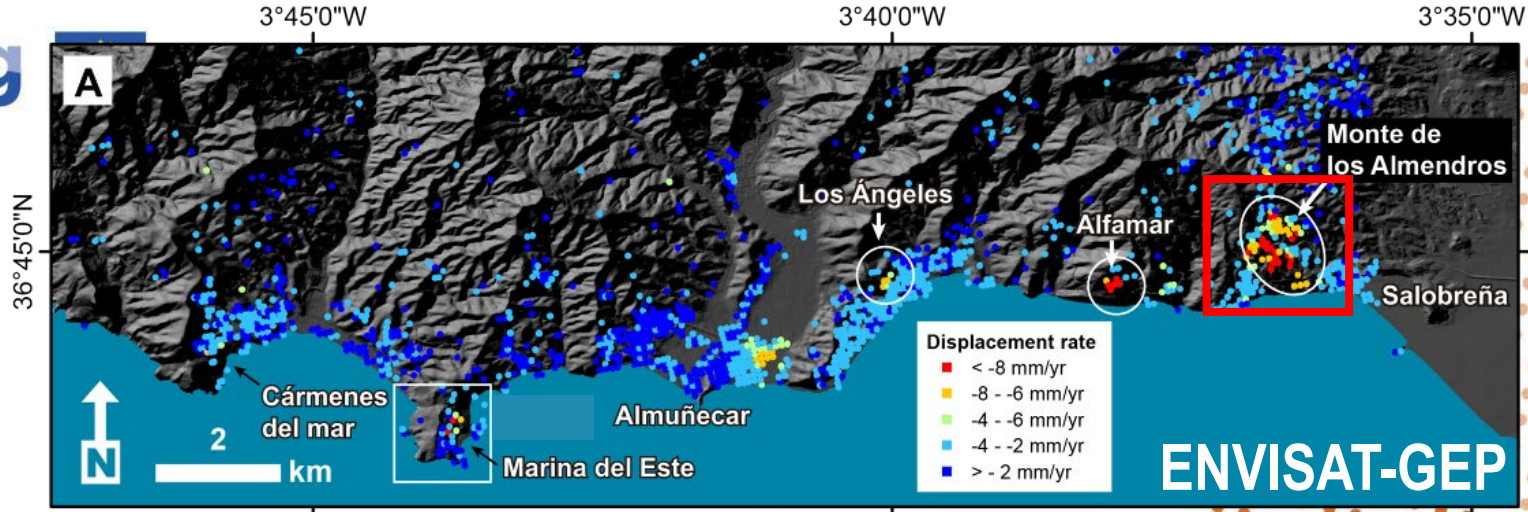


Landslides in the Coast of Almuñécar and its surround

José Chacón¹, Rachid El Hamdouni¹, Clemente Irigaray¹, Jorge Jiménez-Perálvarez¹; Paz Fernández¹, Tomás Fernández², Pedro Alameda¹, José Antonio Palenzuela¹ y José Moya³

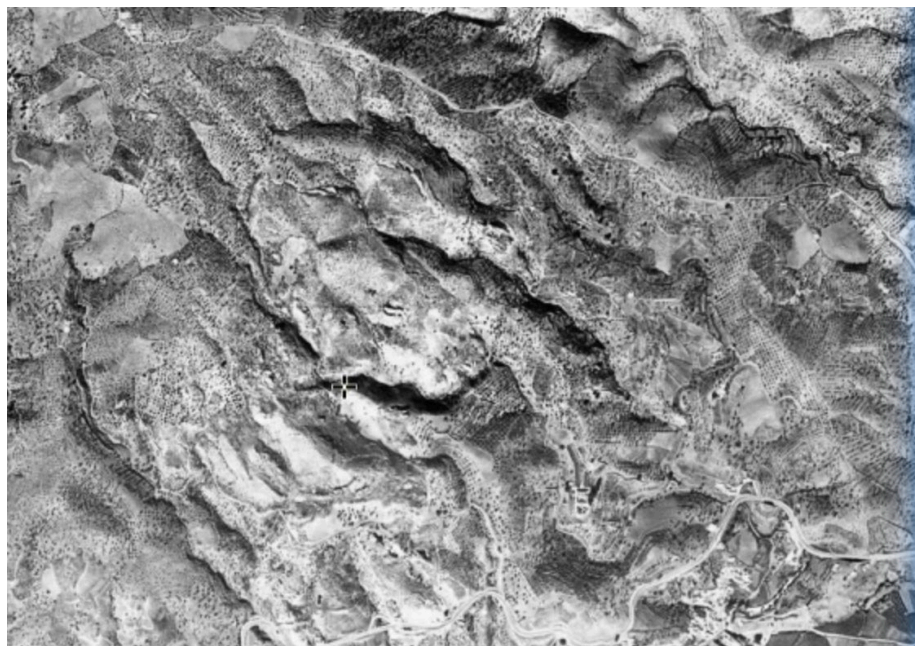


Urban area Rock falls Debris-flows Landslides



Monte Almendros Urban Estate (Granada, Spain)

1957



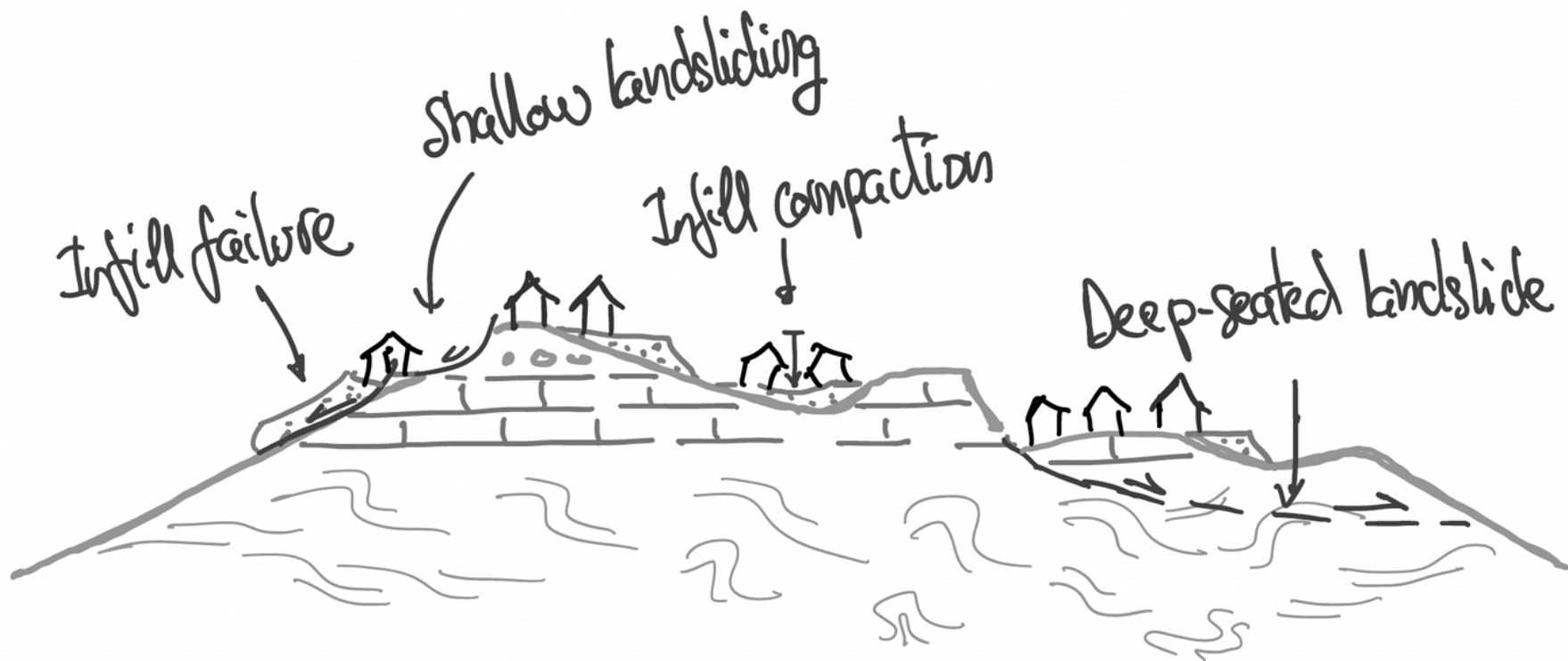
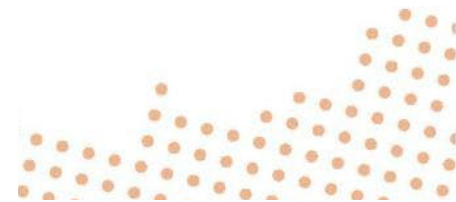
2019



Monte Almendros Urban Estate (Granada, Spain)



Monte Almendros Urban Estate (Granada, Spain)

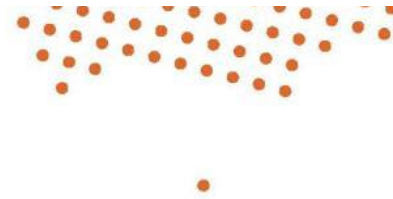


Monte Almendros Urban Estate (Granada, Spain)



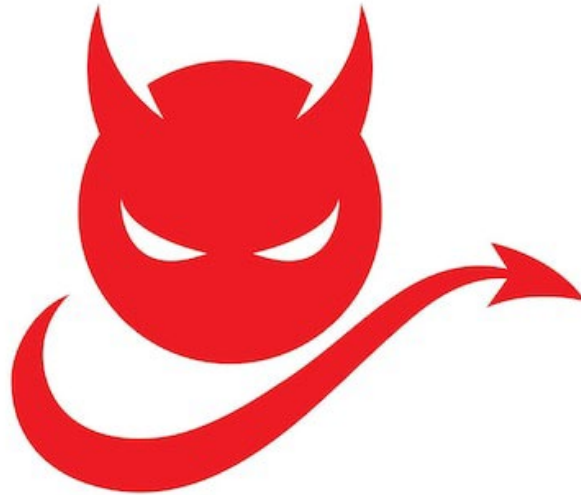
Knowledge needed to interpret InSAR results in Monte Almendros

- Reliability of the DInSAR results
- Geological setting
- Geomorphology
- Historical evolution: Anthropogenic infills
- Slope movements



CONCLUSION

The devil is in the details



CONCLUSIONS

*The ground is diverse
as everything in nature*

*Analysing the terrain is difficult
due to limited access to the subsurface*

CONCLUSIONS

Sometimes the key is...

below surficial deposits and outcropping rocks

or in

*the anthropic activities and landscape
modifications*

CONCLUSIONS

Sometimes **everything is not what it seems** in DInSAR results

In some cases...

- ... a deep knowledge on Geodynamics and Local Geology and History is essential to define the possible origin of movements and to design further research.
- Only additional studies using...
 - Historical information
 - Ground sampling techniques (i.e. boreholes)
 - Lab work – Geotechnical characterization
 - In-situ monitoring systems (Topo, GNSS, Inclino.)
 - Geophysics

& all of this combined with detailed geological surveys

... are necessary to **determine** this origin and **characterize** it

CONCLUSIONS

Why is this so important?

A bad diagnosis leads to a bad solution

CONCLUSIONS

... and now, after the release of the European Ground Motion Service (EGMS)...



Land
Monitoring



European
Environment
Agency

European Ground Motion Service

...a good characterization of the ground in motion is more important than ever

<https://land.copernicus.eu/pan-european/european-ground-motion-service>

Thank you for your attention

Questions?

RISKCOAST
Project



*Galve et al.
2017*

