Monitoring active tectonics via fault micro-displacements in western Slovenia

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Introduction

Western Slovenia belongs to actively deforming north-eastern Adriatic region (Fig. 1, a). Active tectonic deformations of the region are a response to the anti-clockwise rotation of Adria and still ongoing collision with Eurasia. Active deformations are generally accommodated by right-lateral strike-slip and thrust faulting at rates of 2–4 mm/yr.

This poster presents an ongoing project at the Karst Research Institute, monitoring micro-displacements in western Slovenia, for more than 20 years on some sites. More than 40% of the country is comprised of karstic rocks, making it an excelent area for monitoring shallow crustal defromations via fault micro-displacements in karst, induced by tectonics or hydrology.

Methods

Monitoring of active tectonics at the junction of seismically active NW External Dinarides and Southern Alps (Slovenia) through quantification of micro-displacements of faults began in 2004, with a TM 71 extensometer situated in Postojna cave (Fig. 1, 2; NW External Dinarides).

At present there are 12 monitoring sites with TM 71 and 72 extensometers throughout Slovenia, 9 of the instruments are stationed in natural and artificial cave environments (Fig. 1).

Cave climates are considered to be stable and thus provide a reliable environment for micro-displacement monitoring, minimizing or nullifying the effect of fluctuating temperatures on the TM instrument.

The instruments were preferably installed in major regional Dinaric fault zones (NW–SE direction). Where the latter wasn't possible, suitable locations on their ancillary faults was chosen as an indirect substitute.

Research area

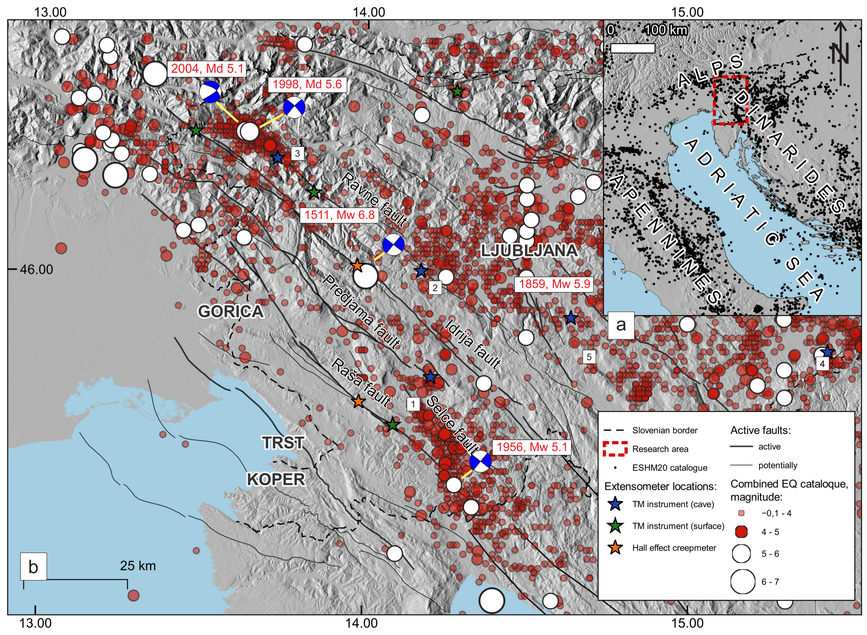


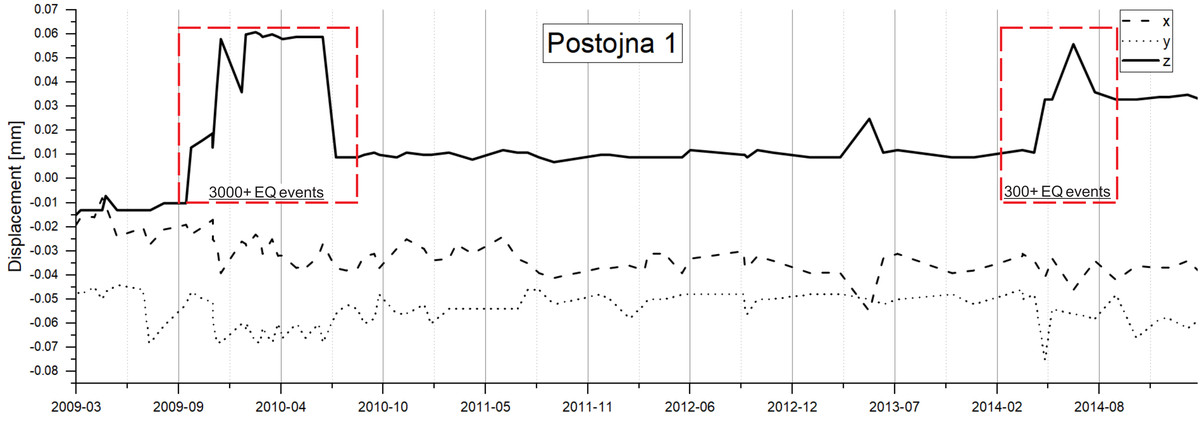
Figure 1: a) Research area and general seismicity shown by ESHM20 catalogue. b) Seismicity of the research area. Combined ESHM20 historic and instrumental seismicity until 1997 with ARSO catalogue (2021). Active faults after Atanackov et al (2021) and EDSF (2023).

TM extensometers in Slovenian caves:

- Postojna cave system (Fig. 1, No 1): 4x TM-72 (automatic)
- Kostanjevica cave (Fig. 1, No 2): 1x TM-72 (automatic)
- Pološka cave (Fig. 1, No 3): 1x TM-71 (manual)
- Sveti Trije Kralji artificial tunnel (Fig.1, No 4): 1x TM-71 (manual)
- Županova cave (Fig.1, No 5): 1x TM-72 (automatic)

Figure 2: a) Postojna cave geostructural map and positons of TM instruments within the cave. b) Po1 site instrument within a fault zone (red polygon). c) A close-up of Po2 site instrument.

Figure 3: From 2002 Postojna cave TM extensometers recorded 2 major micro-displacement events that were in fact tectonic transient signals (red rectangles). Signals that coincide with two local earthquake activities.



Results

All the monitored TM extensometer sites display tectonic displacements, that on average range from a few microns to several tens of microns in time scales from days to years.

Postojna cave is one of the most intriguing micro-displacement monitoring sites (Fig. 3). The site exhibited large tectonic transient signals that coincided with the local swarm-like earthquake activity in the years, 2009-2010 and 2014-2015.

Monitoring site of Pološka cave in Julian Alps (Southern Alps) in addition to recording tectonic displacements, inadvertently records some displacements that are not tectonic in origin, but rather exhibits slope instability, likely deep-seated gravitational slope deformation.

Future agenda

TM extensometer micro-displacement monitoring in Slovenia is still an ongoing project. It is crucial to have a long time-series in order to quantify and characterise the transient and long term tectonic deformations through micro-displacements.

Of late, creepmeters were installed on major active western Dinaric regional faults, in 2022. In an effort to improve the understanding of characteristics and relationships between earthquake activity and potential fault creep.

A fault creep monitoring campaign, with some instruments already installed, on two major active western Dinaric faults, Idrija (Fig. 4) and Raša fault, has begun and more are pending to be installed on the Dinaric fault system.

Figure 4: a) Highly expressed morphology of the seismically active Idrija fault. b) Position of „Hall effect" creepmeter across the Idrija fault.

Acknowledgements

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