Pustertal-Mölltal-Gailtal-Drautal – Periadriatic Fault activity revealed by ruined buildings

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The Periadriatic Fault system was active during the Oligocene and Miocene, producing various, large-scale strike-slip displacements. The Eastern Alpine sector is clearly visible on any relief map of the Alps, raising the interest of geologists whether it is still active today. A recent study by Prince et al. (2023, https://doi.org/10.21203/rs.3.rs-3221175/v1) measured the time of displacements by ultra-low temperature thermometers. Evidence of Late Pleistocene (>200 ky) seismotectonic activity was found. Later, historical records of seismicity along the Periadriatic Fault are exceedingly rare. Instrumental data indicate that seismotectonic deformation is mainly concentrated in the adjacent Southern Alps and Dinarides. We conducted a systematic archaeoseismological study on buildings constructed in the last two millennia along the Pustertal, Mölltal, Gailtal, Drautal, Karavanka, Savinja, and Croatian Periadriatic faults.

Roman settlements (Teurnia, Magdalensberg, Celeia, Siscia) and late Medieval churches (Romanesque in Tyrol, Innichen/San Candido, Millstatt am See, and Gothic in Lienz, Villach) carry evidence for destructive earthquakes.

Besides confirming the 9 AD event at Magdalensberg, the 1348 and 1690 earthquakes, and those in the late 19th and 20th centuries near Zagreb, we discovered several, previously unknown events. Those relevant to regional seismicity are listed below. Our own studies are marked **bold**.

1. An early 13th century earthquake severely damaged the castle of **Tyrol**.
2. The monastery church in **Innichen/San Candido** carries evidence of destruction between 1200 and 1284.
3. Churches and houses of **Lienz** display tilted walls supported by heavy buttresses, probably due to seismic event between 1531 and 1667.
4. Church of **Sachsenburg** was damaged before 1510.
5. Roman **Teurnia** was catastrophically destroyed in the early 3rd century, never to be rebuilt.
6. The Dominican monastery in **Millstatt** am See carries evidence for repeated destruction and restoration in 1201, before 1290, in 1348, and in 1690. Turbidite in the Millstätter See was formed due to the 1201 earthquake.
7. Hillside of Dobratsch suffered a catastrophic, earthquake-generated landslide in 1348.
8. Arnoldstein's hilltop monastery was severely damaged in 1348, illustrated in a contemporary wall painting.
9. Church and town of **Villach** carry abundant evidence of seismic destruction in 1201, 1348, and 1690.
10. Turbidite in Wörther See was formed due to the 1348 earthquake.
11. **Magdalensberg** town and temple suffered damage right before 9 AD. After restoration, one more event hit the town, contributing to abandonment.
12. Homogenites in Lake Bled are witnesses to the 1348, 1511, and 1690 events.
13. Houses of downtown **Ljubljana** (Slovenia) carry buttresses built after the 1895 earthquake.
14. Roman settlement of Celeia (**Celje**, Slovenia) suffered major liquefaction event.
15. Zagreb has been repeatedly exposed to seismicity: 1880, 1906, and 2020.
16. City walls of Roman Siscia (modern **Sisak**, Croatia) were thrown into the moat sometime between 200 and 350 AD.
17. Petrinja earthquake in 2020, causing >100 sinkholes to open up.

Altogether >400 km long faults, >15 seismic sites along 9 segments, >8 destructive earthquakes indicate that the Periadriatic fault has been seismically active during the past two millennia. Intensities up to IX were observed, and magnitudes up to M 7 were estimated, calling for further detailed studies in archaeoseismology.

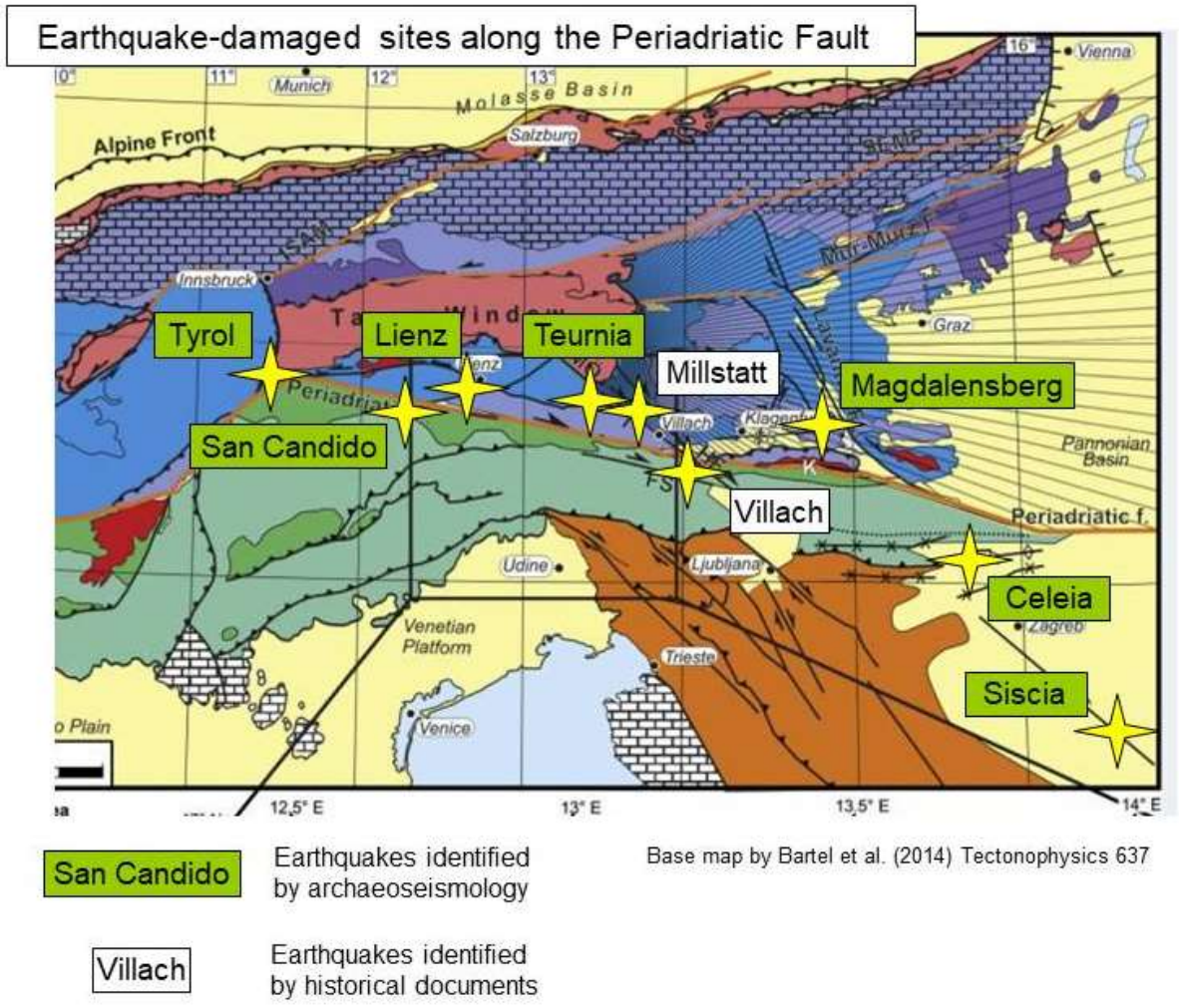

Figure 1: Major earthquake-damaged sites from the past two millennia along the Periadriatic Fault system.