

# AN UNKNOWN DESTRUCTIVE EARTHQUAKE IN TRANSYLVANIA IN THE 1660s – ARCHEOSEISMOLOGY OF THE INLĂCENI UNITARIAN CHURCH (HARGHITA COUNTY, ROMANIA)

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*Abstract.* The 15th century Unitarian church at Inlăceni (Harghita county, Romania) was put on fire by Tartarian marauders in 1661 AD. Gothic masonry vaults collapsed, proven by archaeological excavations. A painted roof panel with Latin inscription, made in 1668, preserved these dates. An archaeoseismological analysis is provided, describing dropped keystone, tilted wall, and collapsed vault. An unknown earthquake of intensity IX occurred between the early 1660s and 1668, unrelated to the Vrancea zone, caused this destruction.

*Key words:* archeoseismology, gothic architecture, historic earthquake, Transylvania, seismicity.

## 1. INTRODUCTION

The Unitarian church at Inlăceni (Énlaka in Hungarian, Harghita county; 46° 25' 44.6" N, 25° 06' 34.5"; monument code: HR-II-m-A-12848.01 80) is famous for the painted wooden panels of the ceiling dated to 1668, and for the Hungarian runic script from the same year [1]. The vaulted gothic church was built in the 15th century. It is of moderate size, 20 by 7 m, having a nave to the west and a sanctuary to the east. A detached tower was built in the early 19th century (Fig. 1). Buttresses support both the nave and the sanctuary, indicating the presence of a former vault (Fig. 2). Collapsed vaults were substituted by a flat, wooden ceiling, decorated with painted panels. One of the panels in the nave displays the story and date of the destruction and restoration of the church (Fig. 3).

*“D. O. M. S. Hocce templum per man, noxius inmanium Tartarorum Anno 1661, in cineres reductum, beneficio et pio erga Deum zelo incolar, Jenlakens, et Martonosien, in honorem uni, veri Dei lacunare tectum arte pictoria insignit A. 1668, Georgius Muznai, pastore existente Johanne Árkosi.”* [1]. In English: “For the Only, Best and Most Powerful God. This church, incinerated in the hands of cruel Tartars in 1661, and covered by paneled ceiling through benevolence of Inlăceni and Firtănuș inhabitants and their dedication to pious devotion towards God, in honour of the only God, was decorated by the craft of painting by Muzsnai György in 1668, when Árkosi János was priest” (Fig. 3).



Fig. 1 – Unitarian church at Inlăceni viewed from southeast. Church was built in the 15th century, the circular wall in the 18th century, the tower in the early 19th century.



Fig. 2 – Gothic buttresses support the nave (left) and choir (right). These are the best evidence that the church had a vault. Serial numbers refer to photos in the Archaeoseismological Database [2]. #0370



Fig. 3 – Ceiling panel with date of construction (1668). Photo: Zoltán Bagyinszki.  
<https://bagyinszki.eu/archives/10362>. Accessed 4 June 2020.

The story briefly described on the panel was corroborated by archaeological excavation in 1976. Removing the wooden floor a 15 cm thick landfill layer was found, dated by a copper coin minted in 1781. Below there was a burnt layer, mixed with brick and stone fragments and pieces of burnt wood. Probably this is what remained of the collapsed vault, roof and church furniture in 1661. A profiled ceramic vault rib proves that the church had a brick masonry vault at that time. At the depth of 50–60 cm a Roman brick floor was found. Removing new plaster from walls an old layer of plaster with lime wash was found, burnt red, testifying to the fire [3].

An archaeoseismological analysis [4,5] is provided to complement historical data on the destruction of Inlāceni church.

## 2. RESULTS

There is a small, but very important, previously overlooked detail, which shows that there was a yet unrecorded event in the history of the church: an earthquake.

This is the disused Gothic gate on the western façade (Fig. 4). There the pointed keystone has been displaced 2–3 cm downwards and 1 cm outwards, towards the viewer (Fig. 5). This symmetrical, seemingly minor displacement bears an important meaning: the church was hit by a destructive earthquake some time during its history.



Fig. 4 – Pointed arch of the western gate. Keystone shifted downwards. #7546

Masonry blocks arranged in an arch form a very solid structure, even without using mortar – if lateral loading is countered by something, *e.g.* a buttress, well known in gothic architecture. Wall of the western façade have the same role. If these walls vibrate in plane, the distance between doorjambes oscillates. Upon extension the keystone drops by an increment, upon compression keystone remains stuck. Downshifted keystone is the best evidence for earthquake shaking [6]. Ultimately, repeated shaking allows the keystone to drop and fall freely and the arch collapses. Computer modelling [7] revealed that keystone drop occurs when there is no more significant vertical load above the arch. One can conclude that it was an earthquake which displaced the keystone of the western gate, both downwards and sideways.

One can raise the question whether there was any other damaging effect of the earthquake. Certainly yes! Deformation of the western gate is possible only, if all the western wall is cross-cut by more-or-less vertical fractures or fissures. Alternatively, about half of the wall should have been collapsed. Neither cannot be excluded in absence of expert wall investigation by removing plaster layers.

However, if there is such a spectacular deformation in the lower part of the wall, one can be sure that not only the upper part of the western façade but much of the vault of the nave collapsed. Here our story is turning back to the destruction mentioned on the wooden panel.



Fig. 5 – Damaged Gothic arch of the western gate. Keystone shifted downwards 2–3 cm, outwards 1 cm towards the viewer. This shift is one of the evidences of an earthquake. #7549

Roof fire does not necessarily cause destruction of the church. A recent example is the burning of the Notre Dame in Paris in 2019. The wooden roof was incinerated, but vaults below in the nave and choir remained mostly intact. Collapse occurred where the small wooden tower above the crossnaive collapsed. Neither nave and aisle walls nor the towers suffered any lasting damage. At Inlăceni the fire caused by the Tartar marauders certainly destroyed all of the

wooden roof and the benches within the nave [1]. Part of the nave vault collapsed: debris was found below the floor. However, the sanctuary vault survived until 1827 [8]. Despite any damage to the vaults, no fire could cause deformation either to the western wall, or to the gate within. Displacement of the keystone, both vertically and horizontally, was certainly caused by an earthquake.

Molnár, the archaeologist, mentioned that the northern wall was dissected by several fissures up to the roof [3]. The wall itself was displaced towards the interior. We did not see any drawing or photograph of these deformations. However, Molnár reported that by adding stone masonry below ground “the lower, tilted part of the northern wall was restored to its original, vertical position”. It allows the interpretation that this wall was tilted inwards. Walls being shaken by seismic waves often remain tilted. A wall like this naturally means that the vault it supported did really collapse.

### 3. DISCUSSION

When did this destructive earthquake happen? The 15th century gothic vault probably survived until the Tartars' raid in 1661, when the church was put on fire, and the vault in the nave collapsed. The ceiling was painted in 1668. These important dates were recorded in the detailed inventory of the *canonica visitatio* (the bishop's visit) in 1801 [9]. Whether the earthquake happened shortly before the attack or within a few years after, we cannot tell at the moment.

The building survived until today in relatively good condition. Therefore the earthquake occurred during the early 1660s–1668 interval. The Tartar marauders visited this part of Transylvania in October 1661. Historical earthquake catalogues [10, 11] mention two quakes in 1661: the one on 13 May, before the Tartar invasion, the other on 12 December, after the invasion. Both were recorded in Braşov. An earthquake was recorded in Baia Mare in 1662, and another in Covasna in 1666. These are the only records we have in this period in Transylvania. Records from Braşov and from Covasna (both are about 100 km from Inlăceni) refer to earthquakes from the Vrancea seismic zone, almost 200 km away. Probably even the strongest earthquakes there were not sufficient to cause collapse in the church. Baia Mare is 170 km to the north from Inlăceni. However, we are aware that historical earthquake catalogues of the Carpathian-Pannonian region contain only a fraction of events: 90% of destructive events in the past two millennia are missing (!) [12]. It is suggested that historical seismology and archaeoseismology should receive more emphasis in research projects to increase the number of seismic events in earthquake catalogues. Not only out-of-the way small villages, like Inlăceni, hold valuable, but unknown information regarding past seismicity. The largest city of Transylvania, Cluj-Napoca has spectacular seismic damage features in its St. Michael church on the main square as found recently [13].

Archaeoseismology uses the EAE13 intensity scale (Earthquake Archeological Effects) [14]. Dropped keystone of a masonry arch indicates I = VII or higher. Out-of-plane shift of masonry blocks suggests minimum IX intensity. The same applies for the collapsed vault and the tilted northern vault: I = IX or higher.

Intensity of the 1977 Vrancea earthquake at Inlăceni was VI–VII [15]. The strongest known Vrancea earthquake in 1940 yielded intensity V–VI [16]. The 1880 mid-Transylvania earthquake, which had the epicentre between Medias and Turda, yielded a barely perceptible intensity IV [17]. It is suggested that displacement along a yet unknown fracture zone caused the Inlăceni earthquake between 1661 and 1668.

#### 4. CONCLUSION

The Inlăceni (Harghita country) Unitarian church was damaged by warfare in 1661, restored in 1668. Between the early 1660s and 1668 a severe earthquake damaged the vault, tilted the northern wall, and let the keystone of the masonry gate shift downwards. Known historical earthquakes were far away from Inlăceni to cause severe harm to the church. Probably a yet unknown fracture zone within Transylvania was responsible for destruction.

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