Inka monumental buildings, a truly seismic resistant architecture?

Reassessment through a quantitative archaeoseismological approach

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For several decades now, engineers **have assumed** that the Inkas developed seismic-resistant construction techniques. But was it **intentional** or only the expression of an inka aesthetic canon? Through an **archaeoseismological approach**, we hope to shed a new light on the close relationship between Inkas and earthquakes.

Geographical/Archaeological Context

Located in the southeastern part of Peru, the Cuzco region lays on the Eastern Cordillera of the Andes, more than **450 km away from the Pacific**. Characterized by steep slopes and large active crustal fault segments that cross the landscape, the Cuzco area gave birth, around 1400, to the largest political entity of South America, the Inka Empire. This culture developed advanced skills in **dry and monumental masonry**. World-famous sites like Machu Picchu and Cusco are well known for their seismic-resistant features: trapezoidal doors and windows and inclined walls.

***Fig.I** Picture of the Santo Domingo convent (Qorikancha) in Cuzco after the 1950 earthquake. Credits: LIFE*

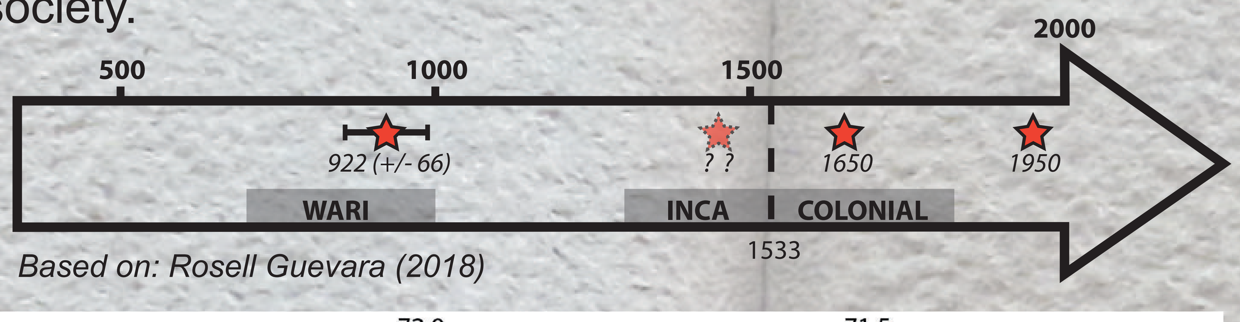
Objectives

While **major earthquakes destroyed Cuzco** twice in its recent history (Fig.I) and several chroniclers mentioned ground-shaking episodes before 1533, the consequences of such events on inka construction techniques and cosmovision are still a neglected topic.

By applying for the first time an archaeoseismological approach in Peru, we want to:

- demonstrate the occurrence of **"prehistorical earthquakes"** in the Cuzco area;
- **improve the seismic catalogue** (Fig.II) by providing complementary information (dating, location and intensity);
- **evaluate the Inka's risk perception** as well as the potential measures implemented by this society.

***Fig.II** Large historical earthquakes that struck the Cusco region.*



Based on: Rosell Guevara (2018)

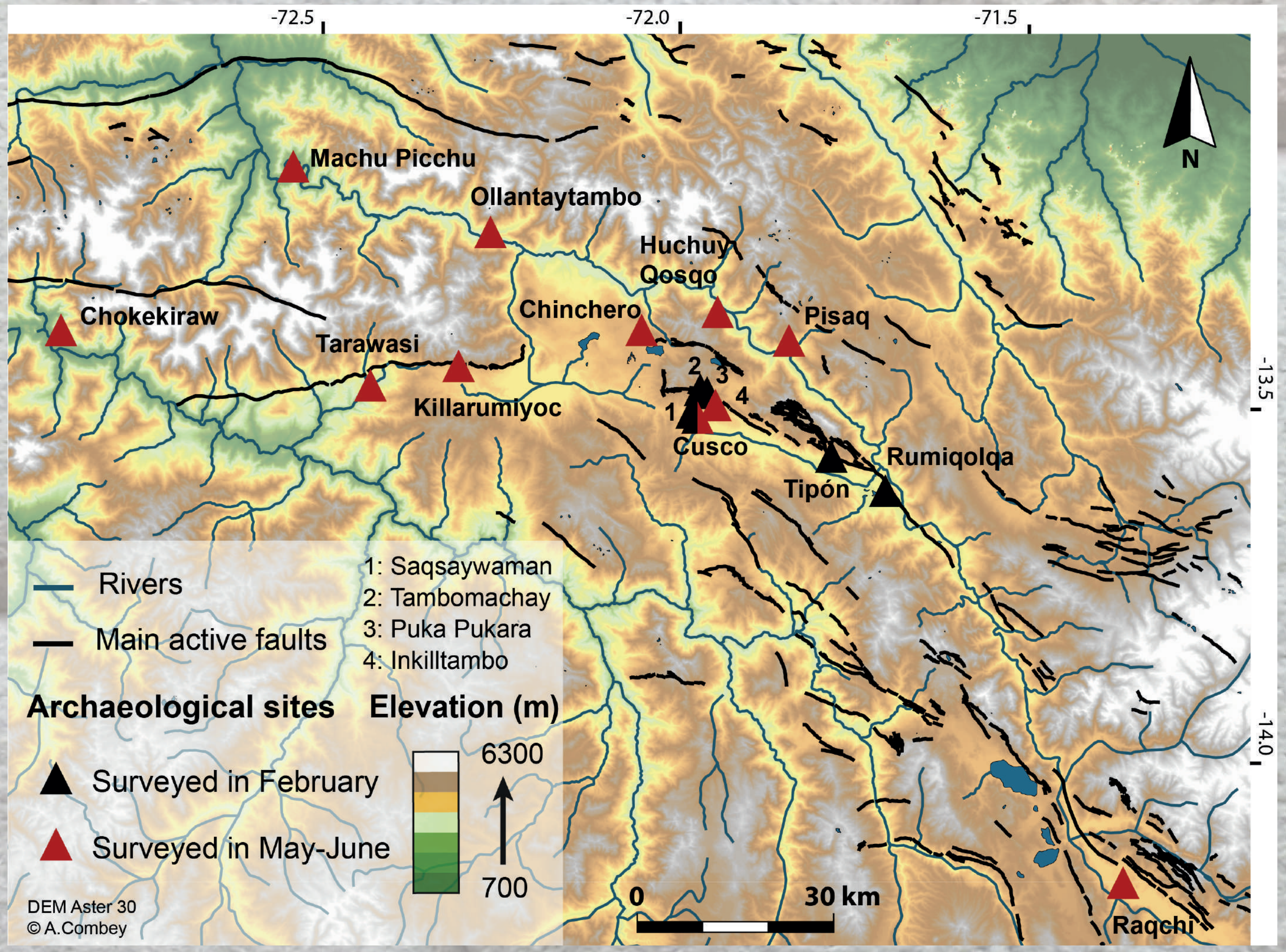
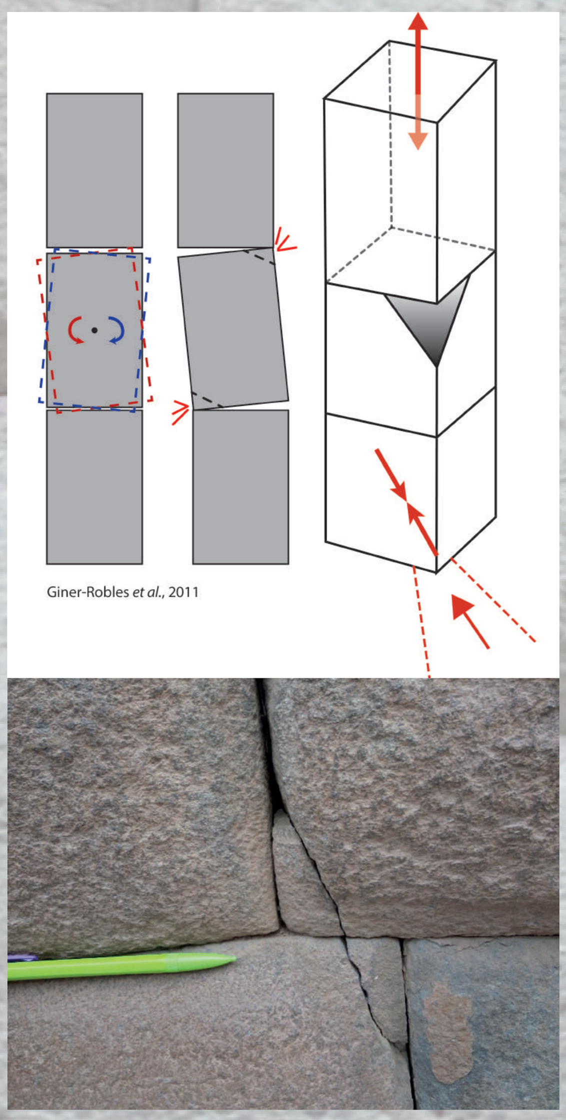


***Fig.IV** Map showing the 17 archaeological sites surveyed during the field campaigns and the location of the main active faults.*

Methodology: using a robust criterion (Berlin, 2018)



From its beginning, archaeoseismological studies have been subject to **constant methodological debate and controversies** (Galadini *et al.*, 2006). That is why we decided to base our investigation on a **field-tested** approach. It is the **first attempt** to register and document a great amount of "Earthquake Archaeological Effects" (EAE) (Rodríguez-Pascua *et al.*, 2011) – defined as seismically induced disorders in archaeological buildings – in pre-Columbian architecture.The method is based on the principle of **directionality** of the EAE (good indicators of the direction of deformation).

To that end, we develop our own **database (RISC)**, inspired by the pioneer initiative of the OPUR database (ANR Recap). RISC database allows us to a quick registration of the location (geographical and architectural), the type and the orientation (azimuth) of the damages as well as the probability of their seismic origin and some indications about *post quem* and *ante quem* dating.

***Fig.III** Diagram of one of the most common type of EAE: the Dipping Broken Corner (DBC) with an illustrative example.*

Preliminary Results

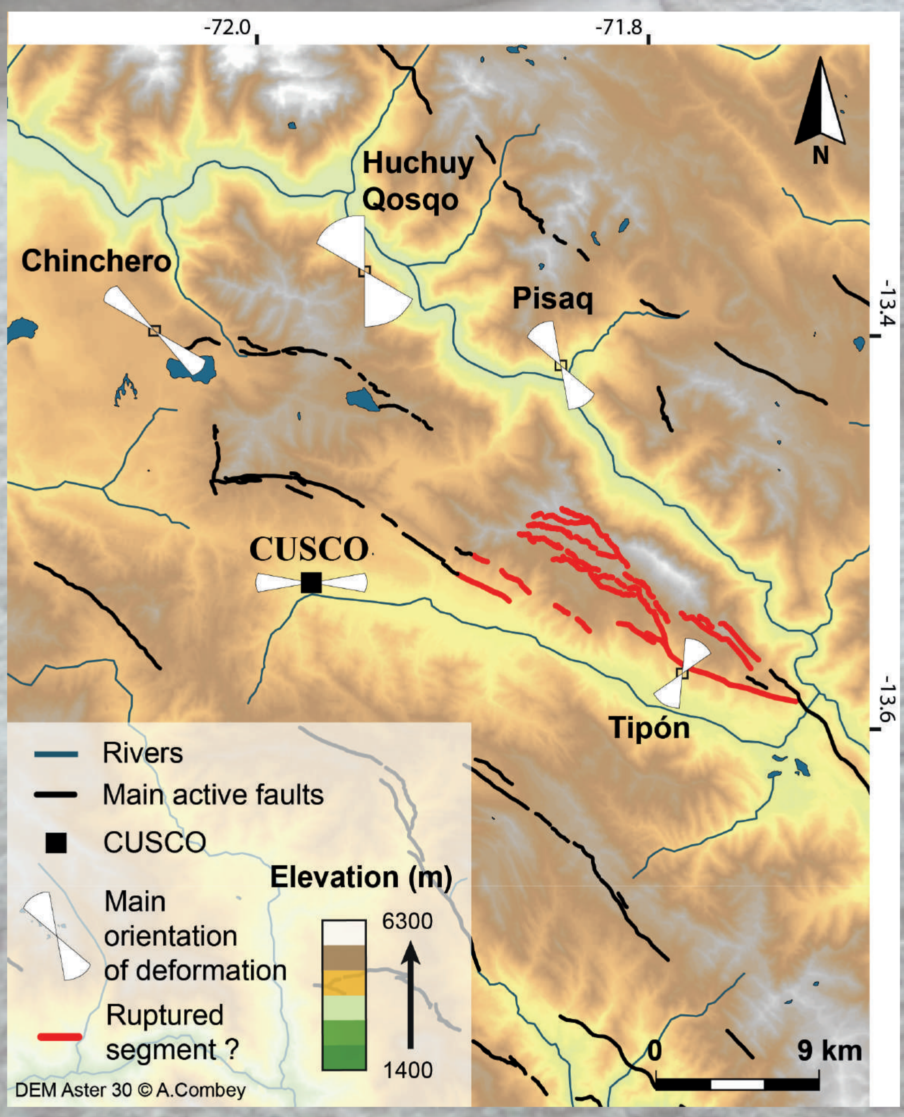


***Fig.VI** Map of the Cuzco basin showing the main orientation of deformation calculated in various archaeological sites of the valley.*

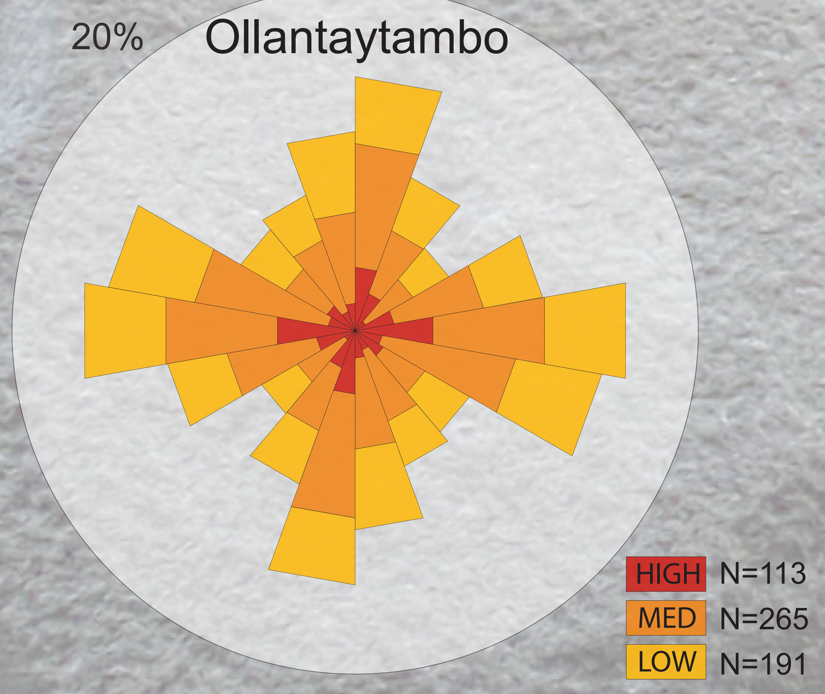


***Fig.V** Rose Diagram created from the Dip azimuth values of the Broken Corners. Categorized according to the level of confidence of the seismic origin.*

Discussion

1) The **large amount of EAE** observed and registered in sites (Fig.V) situated in different geological contexts are confirming the relevance of Inka sites as **good "seismoscopes"**(Sintubin, 2013).

2) Data collected from inka sites in or near the Cuzco valley seem to be consistent, pointing at the large fault complex located at the southeast of the city (Fig.VI). This delineated area suggest the **occurrence of one large seismic event during or just after the inka occupation** (a "prehistoric" event or the 1650 earthquake?).

3) In terms of risk perception in the Sacred and Cuzco Valley, the variation in construction techniques and the quantity of EAE do not reveal **any conclusive difference**.

Conclusion

Beyond its natural interest in improving the seismic catalogue of Peru, the archaeoseismological approach will permit to discuss the intentionality of the so-famous inka stone architecture by providing some **new evidences of past seismicity** in the Cuzco region. If earthquakes were a concrete reality for the Inkas, the need to design seismic resistant building was a natural adaptation. Our first results seem to support this hypothesis.

References

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