Brick characterization determined three groups of bricks:

**GROUP 1**: - bricks samples A, B, C, D, and H; - bricks from constructive phases 1, 2, and 4 (sixteenth-seventeenth century); - fine textured calcareous clay and addition of grog or chamotte; - low firing temperature.

**GROUP 2**: - bricks sample G, from constructive phase 3 (seventeenth century); - very sorted calcareous clay with evidences of vitrification; - high firing temperature.

**GROUP 3**: - bricks samples E and F, from constructive phase 5 (mid nineteenth century); - poor sorted non-calcareous clay and addition of a feldspathic sand; - intermediate firing temperature.

**Morphology of bricks**

- Fine textured calcareous clay
- Group or chamotte
- Reflections of ilite (I) and calcite (C)
- Firing temperature: 800 – 850 °C (except sample A, lower temperature)
- Very sort ed calcareous clay
- Evidences of vitrification

**Results: associated mortars**

- Fabric characterization determined also three groups of mortars in conjunction with data from bricks.

**GROUP 1**: Fk
- high firing temperature.
- very sorted calcareous clay with evidences of vitrification.
- fine textured calcareous clay and addition of grog or chamotte.
- bricks from constructive phases 1, 2, and 4 (sixteenth-seventeenth century).

**GROUP 2**: Gh
- Firing temperature: 850 – 900 °C.
- Evidences of vitrification.
- Group 3 (brick sample G) 16-18 8-10

**GROUP 3**: C
- Poor sorted non-calcareous clay
- Addition of a feldspathic sand and diopside (Dp)
- No reflections of ilite
- Firing temperature: 950 – 1000 °C
- Neither reflections of ilite nor calcite

**Conclusions**

- The combined study of fabric characterization and building geometry and morphology has enabled the recognition of three groups of bricks and associated mortars in the five constructive phases of the “Colegio Mayor de San Ildefonso”.
- Each of the three groups of bricks and associated mortars showed compositional and technological differences, which can be correlated with their chronology and location in the building.
- Building materials from sixteenth and seventeenth century can be easily distinguished to those from nineteenth century. It must be highlighted the high quality of bricks from the clock tower.
- This exploratory study has provided outstanding data on bricks and mortars, which can be very useful in future conservation and restoration strategies.

**Acknowledgements**

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**Goals of the study**

- Characterization of bricks and their associated mortars from the different constructive phases of the “Patio de Santo Tomás”.
- To look for differences or similarities of building materials from the different constructive phases.

**Methodology**

- Combined study of fabric characterization and building geometry and morphology. The study was carried out when wall sections were exposed during recent rehabilitation of the building.

- Observation techniques
  - Polarsed Light Microscopy
  - Scanning Electron Microscopy (SEM)

- Analytical techniques
  - X-ray Diffraction (XRD)
  - Energy Dispersive X-ray Spectrometry (EDS)
  - Thermogravimetric and Differential Thermal Analysis (TG-DTA)

**Constructive phases**

1501-1508 Construction of the main façade (Rodrigo Gil de Hontañon).
1537-1553 Construction of the clock tower (Juan de Ballesteros and later, Juan Garcia Atienza).
1599-1615 Construction of the cloister covered with granite (Jose de Sopena). 
1656-1670 Reconstructions of the “Patio de Santo Tomás”. 
1865-1868 Reconditioning of brick sample G from constructive phase 3 (seventeenth century).

**Places of the sampling**

**Samples**

<table>
<thead>
<tr>
<th>Sample</th>
<th>Type of brick</th>
<th>Morphology of bricks</th>
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<tbody>
<tr>
<td>A</td>
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<td>B</td>
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<td>F</td>
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</tbody>
</table>

**Current view of the “Patio de Santo Tomás”**

 canoe Mayor de San Ildefonso” is a masterpiece of the Spanish Renaissance.

Cardinal Cisneros founded the University of Alcalá in 1495 whose main building was the “Colegio Mayor de San Ildefonso”.

The main building was constructed between 1501 and 1508 under the direction of architect Pedro Gumiel.

The main façade of the building was constructed between 1537 and 1553 under the direction of the master Rodrigo Gil de Hontañon.

The courtyard of the building, named “Patio de Santo Tomás”, was originally made of bricks. However, bricks were later covered with granite during construction of the cloister by José de Sopena between 1656 and 1670.

Late eighteenth century the University of Alcalá entered a period of decadence which ended with its move to Madrid in 1836. The modern University of Alcalá was created in 1917 and the “Colegio Mayor de San Ildefonso” was recovered for academic use.

The main façade of the building was constructed between 1537 and 1553 under the direction of the master Rodrigo Gil de Hontañon.

The main building was constructed between 1501 and 1508 under the direction of architect Pedro Gumiel.

The University of Alcalá was created in 1917 and the “Colegio Mayor de San Ildefonso” was recovered for academic use.

The “Colegio Mayor de San Ildefonso” is a masterpiece of the Spanish Renaissance.

Their main building was founded by Cardinal Cisneros in 1495 and was declared World Heritage Site by UNESCO in 1998, along with the rest of the historic city of Alcalá de Henares.