

# Studying the cracking system in 17-18th century Portuguese Azulejos with SEM

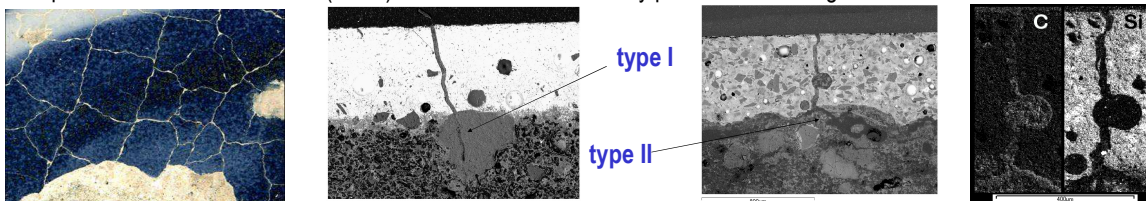
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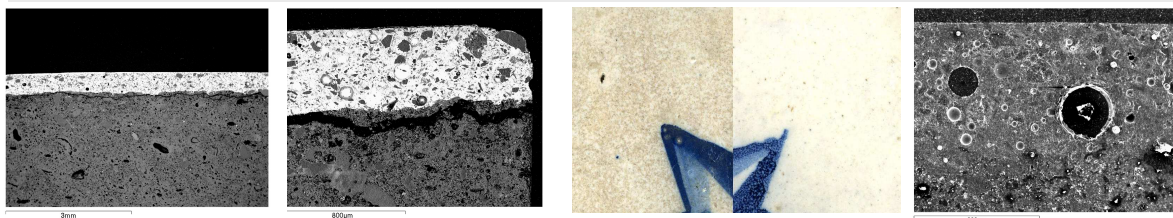
Azulejos are a distinctive mark of Portuguese culture... however they suffer from pathologies resulting in the loss of glaze

The most worrying forms of decay are associated with defects that typically result from the manufacturing process and thus lie in wait in seemingly sound tiles until the proper conditions lead to the setting of decay. Defects include crazing and shivering. Both may result in glaze delamination leading to an empty space between glaze and biscuit, prone to both soluble salt crystallization and to biological growth. A preliminary conclusion from observations onsite was that, when challenged by aggressive conditions, azulejos without defects may remain macroscopically impervious while contiguous tiles with certain manufacturing defects will progressively suffer extensive glaze loss. Hence the importance of a SEM-based study to help understand the cracking patterns and other defects.

Fragile cracked specimens were vacuum impregnated with a resin and then cut, glued on to a glass slide, and sectioned to a width of ca. 2mm. No further impregnation was done after sectioning, so that all volumes filled with resin were originally accessed from the outside of the uncut tile sample. Polishing was done for 5+5 minutes with 9+3µm diamond abrasives. The SEM used was a JEOL JSM-6400 with a X-ray EDS detector INCA X'Sight from Oxford Instruments. Backscattered electrons (BSE) imaging was usually preferred because the lead-rich glaze is enhanced, ensuring clear boundaries. The samples were coated with Au/Pd (80/20) so that Carbon was mainly present in the filling resin.



Above left to right- A pattern of crazing highlighted by efflorescence and BSE images of an azulejo cross section showing Type I crazing cracks propagating vertically from the glaze (brighter colour) into the darker clay body (sample Az02/07) and Type II cracks propagating sideways in the glaze-biscuit interface with X-ray maps of Carbon and Silicon to enhance the paths (sample Az02/06)



Left side: backscattered SEM images showing a shivered tile with characteristic wavy morphology; Right side: a tile affected by an organic staining of the white majolica compared to a sound tile- staining starts inside the bubbles in the glaze and the BSE image proves that some bubbles are accessible from the surface (these are filled with resin and clearly distinguished (sample Az02/03)

The SEM was a valuable technology to help map and understand the defects in historic tiles of Portuguese manufacture. The knowledge thus achieved is now being used in a research project where the onset of decay is simulated aiming at developing counter measures of a preventive nature to help ensure the full longevity that glazed tiles were supposed to enjoy.