

# Cracks make historical paintings less vulnerable to environmental variations

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Historical wood panel paintings with developed craquelure patterns—networks of fine cracks in the paint- are significantly less vulnerable to environmental variations than previously assumed, according to a study in the open access journal *Heritage Science*. The findings offer a potential explanation as to why heavily cracked historical paintings remain stable in environments far from 'ideal' museum conditions.

Painted wood is among the most precious and frequently exhibited category of heritage objects and among the most vulnerable to relative humidity and temperature fluctuations.

A team of researchers at the Polish Academy of Sciences, Université de Strasbourg, France and Yale University, USA investigated changes in susceptibility to fracture for the most brittle component of a wood [painting](#)—the ground layer, or gesso, a mixture of animal glue and white pigment that is applied between the wooden support and the paint. The gesso is strained when wood expands due to increasing humidity or contracts due to desiccation, which can leads to cracking. Knowledge of this as well as development of technical capabilities to control environment precisely have led to stringent climate control specifications for museums, both in temperature (21 or 22°C) and humidity (45-55%).

Lukasz Bratasz, the corresponding author said: "The current environmental standards for the display of painted wood allow for only moderate variations of relative humidity. The safe range was determined

based on laboratory testing of when cracks start to form in new, undamaged material. However, this does not reflect the physical reality of paintings as they age and complex craquelure patterns form. Our research more accurately reflects that physical reality, accounting for changes in the susceptibility to [environmental stresses](#) as paintings age."

To investigate the development of cracks in gesso layers subject to different environmental conditions over time, the authors designed specimens of two wooden panels, which they joined with gesses prepared according to traditional recipes. The specimens were stored at 25°C and [relative humidity](#) of 30, 50, 75 and 90% for two weeks before being subjected to splitting test, which measure how resistant gesses are to cracking.

Using computer tomography to scan historic samples of panel painting, the authors determined the size of existing flaws in the gesso at which new cracks initiate. Those measurements were then used in a computer model of a panel painting to simulate further crack formation. Factoring in the elasticity of the materials and moisture expansion of [wood](#), the authors found that the stress on the gesso decreased as the number of cracks increased over time.

Lukasz Bratasz said: "Stress on the gesso occurs in the areas between cracks. The larger these areas are, the more easily cracks will form. As cracks multiply and the spaces between them become smaller, stress decreases up to a point where, finally, no new cracks will form."

The authors caution that their conclusions are valid for paintings with 'opened' cracks. If cracks are filled in during conservation treatment or varnishing, the vulnerability of a painting to the environment may increase.

Lukasz Bratasz said: "Our findings offer a potential explanation as to

why historical panel paintings with developed craquelure patterns remain stable, even if the environmental conditions they are stored in are far from ideal. We hope that this knowledge may contribute to development and acceptance of more moderate-cost climate control strategies in historic buildings and museums, especially ones that may have limited potential for tighter climate control."

**More information:** Fracture saturation in paintings makes them less vulnerable to environmental variations in museums Bratasz et al.

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