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Ceramic color as an unreliable proxy for firing conditions: new approaches from Gwanbuk-ri site, Korea

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ABSTRACT

Understanding the relationship between the coloration and firing conditions of ancient ceramic provides crucial insights into historical firing technologies. In this study, roof tiles from the Gwanbuk-ri archaeological site, dating to the Baekje Sabi period (538–660 CE), were analyzed to identify the firing technologies and origin of surface color variation and investigate the characteristics of black and non-black roof tiles. Analytical methods included chromaticity measurements, X-ray diffraction, Carbon–Hydrogen elemental analysis, X-ray fluorescence spectroscopy, neutron activation analysis, Mössbauer spectroscopy, and vibrating sample magnetometry. While non-black roof tiles displayed expected correlations between iron oxide phases and color, black roof tiles presented a negative correlation: black coloration was linked to carbon deposition from incomplete combustion at low firing temperatures, rather than iron phase transformations. Additional evidence from the phosphorus and calcium distributions supports the influence of organic fuel ash. The magnetic properties and Mössbauer data enabled the estimation of the firing atmosphere inside the kiln. These findings demonstrate that visual color alone cannot reliably indicate the firing conditions. By integrating chemical, mineralogical, and magnetic data, this study offers a refined interpretive framework for ancient tile technologies and contributes to a broader understanding of the production practices of the Baekje Sabi period.