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Nondestructive Depth Profiling on Roman Coins by Muon Induced X-rays in Japan Proton Accelerator Research Complex (J-PARC)

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We conducted a non-destructive elemental depth analysis of a Roman silver coin excavated from the Tell Mishrifat Hajj Ali Issa, located in northern Syria, housed at the Ancient Orient Museum, using the negative muon beam at the Muon Science Laboratory (MSL), J-PARC. The developed detection system measured muonic X-rays induced at various implantation depths of negative muons, enabling evaluation of the depth profile of silver concentration down to approximately 1 mm from the surface. The results revealed a higher silver concentration near the surface and a lower concentration in deeper regions. For comparison, Edo-period Japanese silver currency ("Chogin") is known to have undergone a surface treatment called irotsuke, in which silver was enriched only at the outer layer due to depletion of silver resources. Previous non-destructive muon analyses successfully identified evidence of such treatments. In contrast, the Roman coin exhibited a distinctly different silver depth profile, raising discussion on whether the enrichment is due to intentional surface processing or the result of long-term corrosion and copper dissolution. In this poster, we also present recent progress in evaluating the depth distribution of oxygen, providing new insights into surface alteration mechanisms.

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