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Capabilities of XRF at Elettra Sincrotrone Trieste in cultural heritage and paleoclimate research with the focus on elemental imaging and multivariate analysis

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X-Ray Fluorescence beamline [1] is developed by Elettra Sincrotrone Trieste in partnership with the International Atomic Energy Agency. End-station consists of ultra-high vacuum chamber housing an advanced 7-axis motorized sample manipulator stage. It operates in the energy range from 3.5 to 14 keV. Combining the tunable monochromatic X-Ray beam with the manipulator that enables different excitation and detection geometries, XRF beamline enables wide range of analytical techniques in one single facility [2]. XRF elemental characterization is possible in conventional reflection geometry (45°/45°) resulting in elemental maps with spatial resolution of 200 μm x 100 μm or in angle-dependent geometry via grazing incidence/exit XRF (GI/GE XRF) for surface analysis and depth profiling to total reflection XRF (TXRF) mode for detection of ultra-trace concentration levels in liquid samples or particulate matter.
Tunable source with the high resolving power and high flux enables the elemental imaging in broad range of research fields. Its great advantage is seen in the cases when overlapping peaks in spectra restrict the acquisition of elemental maps using conventional X-ray sources or other equivalent techniques like Particle Induced X-ray Emission (PIXE) or Scanning Electron Microscopy (SEM). Advantages of tunable X-ray source will be demonstrated on the XRF imaging of S as a trace element in the presence of Ca as a major element when it is known that Ca-K escape peak coincide with the S-Kα signal. Two case studies where S XRF maps were obtained in the presence of Ca matrix will be presented: (i) cultural heritage study used to check the efficiency/integrity of the protective surface coating layer of the stone monument treated with ammonium oxalate [3] and (ii) ongoing study of speleothem imaging combined with stable isotope analysis as a proxy records used for the reconstruction of hydrological variably in southern South Africa.

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