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X-ray fluorescence microscopy of cortical brain structures across scales

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Although it is well recognized that endogenous metals play an important role in healthy brain function, relatively little is known about their precise colocalization with respect to their neurochemical counterparts and anatomical localization across scales. We used synchrotron-based x-ray fluorescence microscopy to explore this issue by imaging postmortem tissue from human cortical brain structures at multiple resolutions. Cortical tissue sampled from prefrontal, temporal and occipital postmortem brain structures were imaged at two beamlines at the Stanford Synchrotron Radiation Lightsource. Quantitative distributions of several metals were collected at resolutions ranging from 0.5 to 100 microns. Elemental maps of unstained tissue showed the differential distribution of metals such as zinc, iron, copper and calcium in gross brain structures as well as at the sub-cellular level. The distribution of particular elements also varied across cortical tissue depth. We also illustrate the differential effects of various histological stains applied prior to x-ray fluorescence imaging. The findings demonstrate the sensitivity of x-ray fluorescence imaging and potential to be cross-correlated with other neurochemical markers at scales ranging from the sub-cellular to whole brain.

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