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The brain mineralogy: sample preparation issues and possible solutions

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The mineralogy of the human brain is determined by the presence of minerals synthesized by the brain itself and exogenous minerals that are up taken from the natural or urban environment. A considerable number of studies were focused on the characterization of the Fe-based particles but giving limited attention to other transition metals-containing oxides. Furthermore, most of the papers dedicated to the topic are focused on the medical aspects of the issue, but a lack of mineralogical and physicochemical in-depth investigation is pretty much the standard. Most of these transition metal-based particles have a role in diseases such as cancer, Alzheimer's, Parkinson's, etc.

One of the reasons for this lack of studies is the difficulty in retrieving and extracting transition metal-based particles from biological material without disrupting their original physicochemical state (a similar problem is encountered when studying asbestos bodies or biogenic apatite). In this contribution, we are presenting a possible experimental approach to the problem, that we are hoping to further develop and standardize. The proposed experimental approach allows for the parallel preparation of samples for ultrastructural characterization in Transmission Electron Microscopy and/or Scanning Electron Microscopy combined with a Focused Ion Beam mapping, with a mineralogical characterization employing atomic resolution microscopy combined with Electron Energy-Loss Spectroscopy and, eventually, 4D-STEM. We have tested the proposed sample preparation protocol on zebra fish larvae using different concentrations of mixed iron oxides as a type pollutant.