

Synchrotron rapid scanning X-ray fluorescence of soft-tissue fossils

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Many geochemical and biological analytical techniques have been employed in the identification and quantification of soft-tissues in the fossil record. However, almost all of these techniques require destructive sampling and are unable to provide high resolution, large scale, spatially resolved chemical information from fossil material. Synchrotron rapid scanning x-ray fluorescence (SRS-XRF) developed at the Stanford Synchrotron Radiation Lightsource (SSRL), non-destructively provides highly sensitive, *in situ* and large scale 2D elemental maps at rapid scanning times (~30 secs/cm²) and reveals the distribution of elements present in concentrations below the detection limits of many conventional geochemical techniques. Furthermore, we have uniquely combined x-ray absorption near edge spectroscopy with XRF rapid scanning, to produce maps showing only organic sulfur species. Our recent multi-technique study of fossilised reptile skin (~50 Mya), employing SRS-XRF, Fourier Transform Infrared (FTIR) spectroscopy and Pyrolysis-Gas Chromatography Mass Spectrometry, strongly suggests that remnants of the living organism's original chemistry (protein compounds) are preserved. Additionally, a new taphonomic model has been proposed to explain the survival of these compounds, involving ternary complexation between organic molecules, trace metals and silicate surfaces.

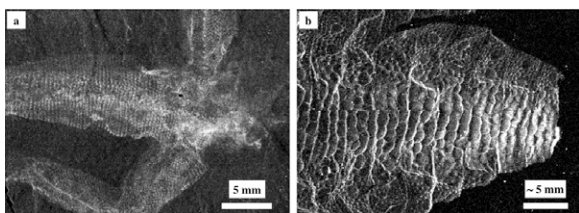


Figure 1: Trace metal loading in a) fossil and b) extant reptile skin.

Fractionation of Cl and Br isotopes during precipitation of salts from their saturated solutions

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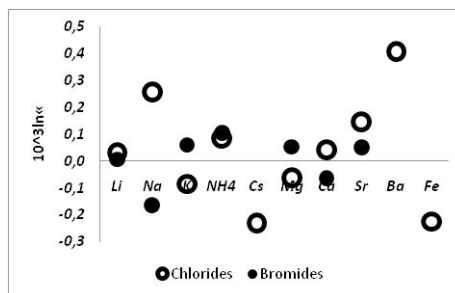
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We determined Cl and Br isotope fractionation of LiCl, NH₄Cl, CsCl, CaCl₂, SrCl₂, BaCl₂, FeCl₃, LiBr, NH₄Br, MgBr₂, CaBr₂ and SrBr₂ between their saturated solutions and first precipitating salts at 23 °C. Considering previous data for NaCl, KCl and MgCl₂ [1] and NaBr and KBr [2] we now have isotope fractionation estimates for common halogen components in marine and terrestrial salt deposits.

¹⁰3lnα for most salts is relatively modest (i.e., a few tenths of a per mil), although clear variations, both positive and negative, are observed.



¹⁰3lnα corresponds to the difference in δ³⁷Cl and δ⁸¹Br between solution and precipitate.

The results obtained in this study can be used to predict Cl and Br isotope fractionation during salt formation in various marine and terrestrial salt deposits. These data can be related to δ³⁷Cl data obtained from evaporites which show that different salts have different ¹⁰3lnα [1] [3].

The observation that ¹⁰3lnα for Cl and Br salts from different elements have different amplitudes and signs might account for the different behaviour of Cl and Br isotopes in natural samples, which show a non-ideal correlation [4] [5].

[1] Eggenkamp *et al.* (1995), *GCA* **59**, 5169-5175. [2] Eggenkamp (1995) EUG VIII Conf., *Terra Nova* **7**, Abs. Supp. **1**, 331. [3] Eastoe *et al.* (2007) *Appl. Geochem.* **22**, 575-588. [4] Eggenkamp & Coleman (2000) *Chem. Geol.* **167**, 393-402. [5] Shouakar-Stash *et al.* (2005) *Anal. Chem.* **77**, 4027-4033