

**CHEMICALLY FRACTIONATED FISSION XENON IN
SCANDINAVIAN ALUM SHALE**

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The Scandinavian Alum Shale Formation was deposited in a large, shallow epicontinental sea that covered substantial part of paleocontinent Baltica. The shale is rich in amorphous organic matter (up to 25 wt. % C) and in syngeneic trace elements, including U [1]. Shales are known to carry large quantities of Xe and Kr and were considered to be a potential sink for “missing” terrestrial Xe [2]. We have analyzed isotopic composition of Xe released from a particularly U-rich part of the Alum Shale known as Kolm (U > 1%) [1].

The Kolm shale exhibits two peaks of fission Xe release: minor at 450–850°C and major at 1000–1300°C. The Xe isotopic composition of the major release is consistent with fission spectrum of ²³⁸U, while the composition of the minor peak is clearly anomalous: ¹³⁶Xe/¹³⁴Xe/¹³²Xe/¹³¹Xe/¹³⁰Xe/¹²⁹Xe = 1/4.7/11.7/9.3/0/6.3. This gigantic anomaly is most likely a result of Chemically Fractionation Fission (CFF) [3] characterized by preferential losses of heavy fission Xe isotopes which have relatively short-lived β-active precursors in fission chains: ¹³⁶I (T_{1/2}=47s) and ¹³⁴I (T_{1/2}=3.7m). This process results in apparent overabundances of Xe isotopes with more retentive precursors. Similar isotopic effect has been observed in Xe released at T<800°C from a volcanogenic U-ore etched with 6M HNO₃ [3].

Our observation confirms intense acid rock drainage and atmospheric weathering of C_{org}-rich alum shales sequence of the Cambrian-Devonian Baltoscandian Basin suggested by fractionation of C, N and S isotopes [4]. Therefore CFF-Xe can indicate the presence and extent of atmospheric weathering and possible leakage of uranium into the environment.

[1] Schovsbo (2002) *GFF* (Journal of the Geological Society of Sweden) 124: 107–116. [2] Podosek et al. (1981) *Geochimica Cosmochimica Acta* 45, 2401–2415. [3] Meshik et al. (2016) *Physical Review C* 93: 44614-1-9. [4] Fru et al. (2016) *Applied Geochemistry* 74, 94–108.