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Extreme tropical weathering profiles as monitors for palaeoenvironmental change

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- **Field work in Antrim, Northern Ireland**
- **Training and application of state-of-the-art Fe-isotope analysis and ICP-MS geochemical techniques**
- **Provide a better understanding of the processes and causes of extreme weathering events**

Rock weathering is a key influence on the composition and evolution of Earth's atmosphere [1], and massively Fe-enriched laterites represent the most extreme form of weathering found anywhere at the Earth's surface [2]. These tropical/sub tropical weathering profiles are commonly 20–100 m thick, show a progression from unaltered bedrock through to an iron-rich duricrust (hardened top soil), and their element enrichments and depletions reflect within-profile variations in redox conditions. Laterites are currently estimated to cover 30% of the exposed continental areas, and 50% of the world's fluvial systems drain through lateritic terrains. Accordingly, understanding the mineral breakdown and element redistribution processes that control their development is fundamental to understanding those weathering processes that, via fluvial systems, control elemental fluxes to the oceans, affect atmospheric CO_2 and O_2 levels and, ultimately, influence climate (via the Ca and Mg cycles).

In crustal rocks, iron occurs as Fe^{2+} and Fe^{3+}, and the Fe^{3+}/Fe^{2+} ratio varies depending upon the local redox conditions. Iron has 4 stable isotopes which can be fractionated by equilibrium and kinetic processes. The relative mobility of Fe in palaeosols and associated iron isotope mass balance has already been used to constrain the timing of O_2 increases in the Proterozoic atmosphere [3], and to assess the relative roles of open and closed system alteration processes. This project will apply a similar approach in order to improve understanding of the role of lateritization during the Late Cretaceous–Palaeocene - an important period of fundamental change to Earth's atmospheric and climatic systems. The student will investigate elemental distribution and iron isotopic behaviour in lateritic weathering profiles developed on substrates of differing localities, composition and age, thus spanning this crucial time frame. The results will provide insight to deep weathering processes in time and space.

The main objectives are:

- Geochemical characterisation of deep weathering profiles preserved in the Antrim basalts (Northern Ireland).
- Geochemical comparison of different suites of well-characterised archived Indian weathering profiles (OU rock archive), using a range of analytical techniques.
- Determine range of Fe-isotope variations throughout the different laterite profiles using a multi-collector ICP-MS.
- Determine the effects of open- versus closed-system processes and other factors controlling Fe-isotope (and related transition metals) fractionations in natural weathering systems through combining detailed elemental analyses with the observed pattern of Fe-isotope variation.
- Utlilise the fe-isotope data to better constrain changing O_2 concentrations during the early Cenozoic.

The Department has a thriving postgraduate community and the postgraduate training programme provides a full range of courses covering: research techniques, scientific methods, information technology, communication and interpersonal skills, which are tailored to the needs of each student.

If you would like to apply or have any queries about this project please contact the first named supervisor either by email to m.widdowson@open.ac.uk or by writing to the address above enclosing a full academic CV and the names and addresses of three academic referees.

References: [1] W.W. Yang, H.D. Holland, (2003), *Am. J. Sci*. **303** (2003) 187–220. [2] B. Kisakürek *et al*. (2004) **212**, 27–44. [3] K..E. Yamaguchi *et al*. (2007), *EPSL*, **256**, 577–587.