Professor Donald G. Fraser

Professor of Earth Sciences

Email: don@earth.ox.ac.uk
TEL: +44 (1865) 272033
FAX: +44 (1865) 272072

Research Profile

Reactions at the mineral-fluid interface control the rates of almost all geochemical reactions. These reactions determine the rates of geochemical mass transport at both low and high temperatures and are thus important in influencing a wide range of geological phenomena varying from metamorphism and diagenesis to levels of CO_2 in the atmosphere and the mobility of chemical waste in the environment. Our aim is to understand how these reactions take place and how they control the speeds of mineral dissolution and precipitation. This work combines experiment and theory. Experimentally, it involves state-of-the-art measurements of single crystal and powder dissolution rates in fluids of well-controlled pH, ionic strength and temperature, combined with determinations of proton penetration depths by ERDA, measurements of mineral surface properties by atomic force microscopy (AFM), X-ray reflectivity and measurements of the coordination states of ions on freshly exposed surfaces by X-ray absorption spectroscopy (REFLEXAFS), and in situ measurements of surface roughening and hydrated growth by synchroton glancing incidence X-ray reflection (GIXR) studies. In parallel with these experiments on carbonates, we have measured dissolution rates from carefully-orientated, cut and polished MgO and olivine single-crystal surfaces and are monitoring the changes in surface roughening during dissolution using small angle X-ray reflectivity. Oxford is fortunate in possessing one of the world's best installations of different ion microprobes. A new development on the Oxford Scanning Proton Microprobe allows measurement of proton penetration in the leached mineral surfaces by 16O- Elastic Recoil Detection Analysis (ERDA) and we are using this technique in collaboration with members of the SPM group in Physics to measure the nature of proton-cation exchange during dissolution. Recently, in collaboration with Xianyu Xue and Masami Kanzaki at the Institute for the Study of the Earth's Interior at Misasa in Japan, I have used MAS NMR to characterise changes in silicate surfaces which occur as a result of this proton-cation exchange – watch this space!

Teaching Profile

My teaching ranges from fundamentals of inorganic chemistry to crystallography and material properties, thermodynamics and planetary chemistry.

Selected Publications

- Fraser, DG, Greenwell, HC, Skipper, NT, Smalley, MV, Wilkinson, MA, Demé, B, Heenan, RK, (2011) 'Chiral interactions of histidine in a hydrated vermiculite clay.', *Phys Chem Chem Phys*. pp. 825-830 doi: 10.1039/c0cp01387k
- Fraser, DG, Fitz, D, Jakschitz, T, Rode, BM, (2011) 'Selective adsorption and chiral amplification of amino acids in vermiculite clay-implications for the origin of biochirality.', *Phys Chem Chem Phys*. pp. 831-838 doi: 10.1039/c0cp01388a
- Li, F, Fitz, D, Fraser, DG, Rode, BM, (2010) 'Arginine in the salt-induced peptide formation reaction: enantioselectivity facilitated by glycine, L- and D-histidine.', *Amino Acids*. pp. 579-585 doi: 10.1007/s00726-010-0479-5
- Li, F, Fitz, D, Fraser, DG, Rode, BM, (2010) 'Catalytic effects of histidine enantiomers and glycine on the formation of dileucine and dimethionine in the salt-induced peptide

formation reaction.', *Amino Acids*. pp. 287-294 doi: 10.1007/s00726-009-0249-4

- Li, F, Fitz, D, Fraser, DG, Rode, BM, (2008) 'Methionine Peptide Formation under Primordial Earth Conditions', *Journal of Inorganic Biochemistry*. pp. 1212-1217 doi: 10.1016/j.jinorgbio.2007.12.020
- Fraser, DG, Li, F, Fitz, D, Fraser, DG, Rode, BM, () 'Methionine peptide formation under primordial earth conditions', *Journal of Inorganic Biochemistry*. pp. 1212-1217
- Fraser, DG, Deak, DS, Liu, S, Castell, MR, (2006) 'Structure of vapour deposited adenine on a nanostructured perovskite surface studied by STM', *Faraday Discussions*. pp. 303-309 doi: 10.1039/B518079A
- Fraser, DG, (2005) 'Acid-base properties and structons: towards a structural model for predicting the thermodynamic properties of silicate melts', *Annals of Geophysics*. pp. 549-559 doi: 10.4401/ag-3219
- Xue, X, Kanzaki, M, Fraser, DG, (2002) 'The dissolution mechanisms of forsterite and enstatite: Constraints from Si-29 and H-1 MAS NMR', *GEOCHIMICA ET COSMOCHIMICA ACTA*. pp. A853-A853
- Mejias, JA, Berry, AJ, Refson, K, Fraser, DG, (1999) 'The kinetics and mechanism of MgO dissolution', *CHEMICAL PHYSICS LETTERS*. pp. 558-563 doi: 10.1016/S0009-2614%2899%2900909-4
- WOGELIUS, R, REFSON, K, FRASER, D, GRIME, G, GOFF, J, (1995) 'PERICLASE SURFACE HYDROXYLATION DURING DISSOLUTION', *GEOCHIMICA ET COSMOCHIMICA ACTA*. pp. 1875-1881 doi: 10.1016/0016-7037%2895%2900070-G
- Refson, K, Wogelius, RA, Fraser, DG, Payne, MC, Lee, MH, Milman, V, (1995) 'Water chemisorption and reconstruction of the MgO surface.', *Phys Rev B Condens Matter*. pp. 10823-10826 doi: 10.1103/PhysRevB.52.10823

view Extended Publications

Published Books

WOOD B.J. and FRASER D.G. "Elementary thermodynamics for geologists." Oxford University Press, 303 pp.

FRASER D.G. "Thermodynamics in Geology" Pub. D. Reidel, xii + 410 pp.