

Geoffrey Stuart Boulton

Professional curriculum vitae

1. **Current position:** Regius Professor of Geology Emeritus, University of Edinburgh
2. **Contact:** School of Geoscience, Grant Institute, King's Buildings, Edinburgh EH9 3JW.
Mobile: 44 (0)7590978510
3. **University degrees:**
 - B.Sc. in Geology with 1st class honours, (Birmingham) - 1962
 - Ph.D. Geology, (Birmingham) - 1967
 - D.Sc. Geology, (Birmingham) - 1978
4. **Career since graduation**
 - Scientific Officer, Geological Survey of Great Britain - 1962-64
 - Demonstrator, Department of Geology, University of Keele - 1964-65
 - Research Fellow, Department of Geology, University of Birmingham - 1965-68
 - Hydrogeologist - Kenya Department of Water Supply - 1968:
 - School of Environmental Sciences, University of East Anglia - 1968-80
(Lecturer:1968-76, Reader:1976-80)
 - Professor of Earth Science at the University of Amsterdam - 1980-86

At the University of Edinburgh:

 - Regius Professor of Geology -1986-2008
 - Head of Department of Geology, then Geology and Geophysics -1986-93
 - Provost and Dean of Science and Engineering - 1994-99
 - Vice Principal - 1999 – 2009
 - Regius Professor of Geology Emeritus – 2008 –
5. **Some former external responsibilities**
 - Royal Society: Council: 1995-97, 2012-2014; Chair of its Earth Science and Astronomy Committee: 1994-1996; Research Grant Board: 1994-98; Chair of Hooke Committee for Royal Society Exhibitions: 1998-2000.
 - Member of the Royal Commission on Environmental Pollution - 1994-2000
 - UK Representative to the International Union of Quaternary Science - 1997-2000
 - Member of the Scottish Higher Education Funding Council and chairman of its Research Advisory Committee - 1997-2003
 - Member of the Oxburgh Review of Earth Science – 1997-1998
 - President of the Quaternary Research Association - 2001-2004
 - President of the Geological Society of Edinburgh - 2002-2005
 - Chair of the Research Policy Committee of the League of European Research Universities - 2002-2009
 - Member of the Scottish Government Science Advisory Committee - 2002 - 2008
 - Member of Natural Environment Research Council, Chair of its Earth Science and Technology Board and of its Polar Science Board - 2003-2008

- Advisory Committee to the Chinese Academy of Science in creating the Institute for Tibetan Science - 2004
- UK Prime Ministers Council for Science and Technology - 2004-2010
- Chair of the Senate of the British University in Dubai - 2005-2009
- Chair of University Reviews: research at the University of Lund - 2007; comprehensive review of University College Dublin - 2011
- UK Representative to the International Geological Congress - 2008
- Member of the independent (Russell) Review of “Climategate” - 2010
- General Secretary of the Royal Society of Edinburgh – 2007-2011
- President of the Scottish Association for Marine Science (SAMS) – 2012-2018
- President of the Committee on Data for Science and Technology (CODATA) - 2014-2018
- Chair of the Royal Society Science Policy Centre – 2012-2014

6. Current external responsibilities

- Chair of the Academic Advisory Council, University of Heidelberg - 2006 -
- Member of the Strategic Council, University of Geneva - 2010-
- Advisory Council of the African Open Science Platform - 2018 -
- Governing Board of the International Science Council and Vice Chair of its Committee on Science Planning and Review - 2018 -
- Member of the Review Panel for the Research Council of Norway - 2021 -

7. Current work for the ISC Governing Board

I have been an active member of the GB and as Vice Chair of the Committee for Science Planning, heavily involved in several ISC work streams as follows:

- principal author of the ISC 2019-2021 Action Plan and one of three principal authors of the draft Action Plan for 2021-2024
- author of the 28pp ISC statement on Open Science (see section 13b) submitted to UNESCO as a contribution to its draft Recommendation on Open Science
- led the survey of ISC members about the first draft of the UNESCO recommendations
- led ISC members delegation to UNESCO Open Science discussions – resultant article submitted to the Journal “Science”
- chair of the project on scientific publishing, involving membership debates, publication of the report “Opening the Record of Science” (see 13b), and leading the Steering Group on actions to achieve reform
- member of the Oversight Panel for the Covid-19 Outcomes Scenario project
- representative of ISC in its role of co-champion of the UNDP/UNEP/ISC/UBA led project CODES: a Digital Planet for Sustainability
- currently preparing an ISC position paper on “Science as a Global Public Good”
- made 15 presentations to external bodies on the work of ISC

8. Honours for scientific work

- Lyell Fund of the Geological Society - 1980
- Kirk Bryan Award of the Geological Society of America – 1982
- Fellow of the Royal Society of Edinburgh (Scotland’s National Academy) - 1990

- Fellow of the Royal Society - 1992
- Order of the British Empire – 2000
- Seligman Crystal of the International Glaciological Society – 2001
- Lyell Medal of the Geological Society - 2006
- Science Medal of the Institute for Contemporary Scotland – 2006
- Honorary Fellow of the International Union for Quaternary Research, 2007
- Commandeur de l'Ordre des Palmes Academiques (French Government) - 2008
- Inaugural Croll Medal of the Quaternary Research Association - 2010
- Gold Medal of the Royal Geographical Society - 2014
- UK Polar Medal - 2015
- Honorary science doctorates from the Universities of Heidelberg (2008), Chalmers (DTechnol) (2002), Birmingham (2007) and Keele (2007)

9. Teaching and academic management

I have been very committed to the educational role of universities. The paper “What are universities for?” (<https://www.leru.org/files/What-are-Universities-for-Full-paper.pdf>) authored with Colin Lucas, which has been internationally influential, reflects our shared educational philosophy and our view of the role of universities. My principal teaching commitments in the three universities in which I have been employed have been in general geology and environmental science to first year students in particular, the Quaternary, geohydrology and engineering geology. In positions of university management at Edinburgh University, I have exercised a strong belief in the value of bringing cognate areas of study together. As Head of the Geology Department, I brought Geology and Geophysics together and raised funds for them to be located under one roof. As Provost and Dean of Science and Engineering I brought together four separate Departments to create a single School of Informatics (now the University's most successful academic unit). As Vice Principal I worked with the then Principal, Stewart Sutherland, to create the current Edinburgh academic system of four Colleges, each with relatively large individual Schools. In this I was also responsible for bringing Geology and Geophysics, Geography, Forestry and parts of Ecology together in a new School of Geoscience

10. Scientific contribution

I have produced over 150 peer-reviewed scientific publications, primarily in the fields of glaciology and glacial geology, mostly concerned with the dynamics of flow of glaciers and ice sheets, glacio-hydrological systems, erosional and depositional processes and geo-mechanical properties of glacial sediments. Current projects comprise studies of time-dependent changes of the bed of the Rutford Ice Stream in Antarctica and time-dependent changes in hydrological systems beneath the Vatnajökull ice cap, Iceland. Research funding over the period 2005 – 2015 comprised £1.58M from UK and EU sources. To my horror, I calculate that I have given over 215 invited talks and presentations over the last 15 years at meetings/conferences and to public audiences. My work has necessarily involved a very wide range of national and international collaborations, some funded, some not.

A special issue of Quaternary Science Reviews in 2009 (Editorial / Quaternary Science Reviews 28, 2009, 580–583 -

<https://www.sciencedirect.com/science/article/abs/pii/S0277379109000572>) was published dedicated to my work, usefully summarising some scientific achievements during the period until 2009 and as reproduced below. References to selected published work in section 11 are shown by letters in parentheses.

1960s

- First demonstration of the age of the last glaciation in Britain (a)
- Demonstration that single glacial episodes can produce multiple till sequences

1970s

- Characterised the nature of glacial sedimentary sequences and their relation to the thermal regime of the parent glacier (b)
- Demonstrated rates of weathering in newly deglaciated terrain
- First quantitative theories of glacial erosion and glacial deposition (c-d)
- Demonstrated the relationships between glacial sedimentary processes and geotechnical properties (e)
- First use of the land systems approach to characterize different glacial sedimentary systems
- Application of modern glaciological theory to produce the first simulation model of a Pleistocene ice sheet (f)
- First direct measurement of stress and erosion rates at the base of an active glacier (g)
- First demonstration of shear deformation beneath glaciers and their implications for glacial sedimentation (h)

1980s

- Development of the structure of the southern Iceland coastal zone during the Holocene
- Modern and Holocene patterns of sediment dispersal over the southern continental shelf of Iceland
- Demonstrated the nature and rheology of sediment deformation beneath glaciers (j)
- Demonstrated the effect of deforming subglacial sediments on the form and dynamics of Pleistocene ice sheets
- Theory of drumlin formation by sediment deformation based on observation of modern process and drumlin form and structure (k)
- Theory of erratic dispersal by glaciers (l)

1990s

- Demonstration of the architecture of glaciomarine sediments and their relation to patterns of glacio-isostatic crustal flexure
- First recognition of the existence of major, large scale crossing lineation sets produced by Pleistocene ice sheets, and the dynamic ice sheet behaviour they reflect (m)
- Theory of glacial erosion and deposition due to sediment deformation (n)
- Large scale structure of a modern push moraine and the role of porewater pressures
- The sedimentary impact of major recent glacier surges on large scale sediment architecture
- First recognition of the major significance of groundwater flow beneath glaciers and ice sheets, including the impact on geotechnics (o)

2000s

- Demonstration of the ubiquitous nature of ice streams in the last European ice sheet and their relations to pattern of advance and decay of the ice sheet (p)
- First successful simulation model of streaming in a Pleistocene ice sheet and its significance (q)
- First direct measurements of groundwater flow and its impacts beneath an active glacier (r)
- First measurements of the groundwater regime associated with esker-forming tunnels (s)
- Quantitative theory of formation of esker systems and demonstration of the fundamental role of groundwater flow in modern and Pleistocene glaciers (s)
- A new theory of ice sheet drainage and its role in ice sheet dynamics and stability (t)

Some this work has been highly relevant in to two areas of commercial and public policy concern in particular:

Geological disposal of nuclear waste. Primarily concerned to create scenarios of possible future climate and environmental changes and their potential impacts on deep sub-surface repositories. I have been involved, sometimes as PI, in projects funded by the European Commission, by the Canadian Nuclear Decommissioning Board and by the Swedish Nuclear Fuel and Waste Management Company (SKB).

Geotechnical properties of glacial sediments. My work on the geotechnical properties of glacial sediments is highly relevant to ground engineering in formerly glaciated regions (e.g. most of northern Eurasia and northern North America) and led to a number of commercial contracts. The largest and most interesting was in a major legal case regarding responsibility for collapse of the entrance tunnel to the Öresund Bridge between Denmark and Sweden. Our investigation showed the collapse was due to pipes of a soft carbonate that we concluded were created due to expulsion of methane from beneath the last European ice sheet.

11. Selected references to scientific articles

References have been selected below that are the source of some of the achievements listed in 10.

- a) Boulton, G.S. and Worsley, P. 1965. Lake Weichselian glaciation in the Cheshire-Shropshire Basin. Nature, 207, No. 4, 998, 704-6.
- b) Boulton, G.S. 1972. The role of thermal regime in glacial sedimentation. Institute of British Geographers. Special Publication, No. 4, 1-19.
- c) Boulton, G.S. 1974. Processes and patterns of glacial erosion (In Coates, ed.) Glacial Geomorphology, New York State University. 41-87. (Award from the Geological Society of America, for a "distinguished contribution to geomorphology").
- d) Boulton, G.S. Processes and patterns of subglacial sedimentation: a theoretical approach. In Wright and Moseley, eds). Ice-Ages: Ancient and Modern. Seel House Press. 7-42.
- e) Boulton, G.S. and Paul, M.A. 1976. The influence of genetic processes on some geotechnical properties of glacial tills. Quarterly Journal of Engineering Geology, 9, p 159-94.

- f) Boulton, G.S., Jones, A.S., Clayton, K.M. and Kenning, M.J. 1977. An ice sheet model and patterns of glacial erosion and deposition in Britain. In Shotton, F.W. ed. *British Quaternary Studies*. Oxford University Press, 231-46.
- g) Boulton, G.S., Morris, E.M., Armstrong, A.A. and Thomas, A. 1979. Direct measurement of stress at the base of a glacier. *Journal of Glaciology*, 22, No. 86, 3-24.
- h) Boulton, G.S. and Jones, A.S. 1979. Stability of temperate ice sheets resting on beds of deformable sediment. *Journal of Glaciology*, 24, 29-43. (Later established by field experiments that I led (j). Characterised as “a paradigm shift in glaciology”).
- i) Boulton, G.S., Baldwin, C.T., Peacock, J.D. and others 1982. A glacio-isostatic facies model and amino-acid stratigraphy for Late Quaternary events in Spitsbergen and the Arctic. *Nature*, 298, No. 5873, 437-441.
- j) Boulton, G.S. and Hindmarsh, R.C.A. 1987. Deformation of subglacial sediments: rheology and geological consequences. *Journal of Geophysical Research*, 92, 9059-82.)
- k) Boulton, G.S. 1987. A theory of drumlin formation by subglacial deformation. In Rose, J. and Menzies, J. *Drumlins, Balkema*, Rotterdam, 25-80.
- l) Boulton, G.S. 1984. Development of a theoretical model of sediment dispersal by ice sheets. *Prospecting in areas of glaciated terrain*, 1984. Institution of Mining and Metallurgy, London. 213-224.
- m) Boulton, G.S. and Clark, C.D. 1990. A highly mobile Laurentide ice sheet revealed by satellite images of glacial lineations. *Nature*, 346, 813-817.
- n) Boulton, G.S. 1996. Theory of glacial erosion, transport and deposition as a consequence of subglacial sediment deformation. *Journal of Glaciology*, 42(140), 43-62.
- o) Boulton, G.S., Caban, P.E. and van Gijssel, K. 1995. Groundwater flow beneath ice sheets : Part I - Large scale patterns. *Quat. Sci. Rev.*, 14, pp. 545-562. Part II - Its impact on glacier tectonic structures and moraine formation. *Quat. Sci. Rev.*, 14, pp. 563-587.
- p) Boulton, G.S., P.W. Dongelmans, M. Punkari and M. Broadgate. 2001. Paleoglaciology of an ice sheet through the Weichselian. *Quaternary Science Reviews*, 20(4), 591-625.
- q) Boulton, G.S., M. Hagdorn and N.R.J. Hulton. 2003. Streaming flow in an ice sheet through a glacial cycle. *Annals of Glaciology*, 36, 117-128.
- t) Boulton, G.S., and Zatsepin, S. 2006. Hydraulic impacts of glacier flow over a sediment bed. *Journal of Glaciology*, Vol. 52, No. 179, 2006.
- r) Boulton, G.S., Lunn R., Vidstrand. P. and Zatsepin, S. March 2007. Subglacial drainage by groundwater-channel coupling, and the origin of esker systems: Part I – Glaciological observations, *Quaternary Science Reviews*, 26, 1067-1090. Part II – Theory and simulation of a modern system. *Quaternary Science Reviews*, 26, 1091-1105.
- s) Boulton, G.S., Hagdorn, M., Maillot, P.B., and S. Zatsepin. 2009. Drainage beneath ice sheets: groundwater–channel coupling, and the origin of esker systems from former ice sheets. *Quaternary Science Reviews* 28 (2009) 621–638. (Note that the absence of a physically-based drainage theory for ice sheets, has inhibited our capacity to create predictive models of ice sheet behaviour and resultant sea level change under conditions of global warming).

12. Policy work on Science, Research and the Universities

My work in this domain has largely been undertaken through the medium of bodies with a specific science policy role or remit. The following are reports produced in this way whilst I have been a member:

Royal Commission on Environmental Pollution

- Transport and the Environment - 1994
- The Sustainability of Soils - 1996
- Environmental Standards - 1998
- Energy: the Changing Climate - 2000

Scottish Universities Funding Council (SHEFC, then SFC)

As chair of the Council's Research Committee, I was centrally involved in two major initiatives: the development of a "knowledge transfer" network to stimulate innovation in Scottish universities, and its commercial take-up; and the inter-University networks designed to enhance collaboration, critical mass and efficient technical support systems in key areas of research.

UK Prime Minister's Council for Science and Technology

- Policy through Dialogue (chair) - 2005
- Priorities for UK Energy Strategy - 2006
- Government Support for Nanotechnology - 2006
- Strategic Decision-Making for Technology Policy – 2007
- A National Infrastructure for the 21st Century - 2009

League of European Research Universities (all as lead author)

- The European Higher Education and Research Areas and the Role of Research-Intensive Universities - 2002
- Research Intensive Universities as Engines for the "Europe of Knowledge" - 2003
- Unlocking Europe's Intellectual Potential – Universities and a European Common Market for Research - 2004
- Growth, Research Intensive Universities and the European Research Council - 2005
- Competitiveness, Research and the Concept of a European Institute of Technology - 2006
- Universities and Innovation: the Challenge for Europe - 2006
- The Future of the European Research Area - 2007
- What are universities for? (Geoffrey Boulton & Colin Lucas) – 2008

Royal Society of Edinburgh

As General Secretary, I instigated a formal series of Advice Papers from a Scottish perspectives to influence policies at Scottish, UK and EU levels and Briefing Papers for the Scottish Parliament. Approximately 20 per year were created after 2008 during my tenure. Examples include:

- The Control of Animal Diseases in Europe (Advice Paper) - 2008
- The Climate Change Scotland Bill (Briefing Paper) - 2009
- Picking Winners or Responding to Demand: Science and Engineering at the Heart of Government Policy (Advice Paper) - 2009
- Sustainable Fisheries (Advice Paper) - 2009
- The Curriculum for Excellence (Briefing Paper) - 2010

- Towards a Common Strategic Framework for EU Research and Innovation Funding (Advice Paper) - 2011
- Management of Flood Risks (Advice Paper) - 2011

Royal Society

- Devolution and Science (chair) - 1999
- Developing UK Policy for the Management of Radioactive Waste (chair) - 2002
- The Long-term Management of Radioactive Waste: the Work of the Committee on Radioactive Waste Management (CoRWM) (chair) - 2006
- Strategy Options for the UK's Separated Plutonium (chair) - 2007
- Science as an Open Enterprise (chair) - 2012

International Science Council

- Open Data in a Big Data World (chair) - 2015
- Open Science for the 21st Century (chair) – 2020
- Opening the Record of Science: making scholarly publishing work for science in the digital era (chair) - 2021

13. Selection of major published policy reports from the last decade

Boulton, G., Campbell, P., Collins, B., Elias, P., Hall, W., Laurie, G., et al. 2012. Science as an open enterprise. Royal Society. Available at: <https://royalsociety.org/topics-policy/projects/science-public-enterprise/report/>

Boulton, G., Hodson, S., Serageldin, I., Qhobela, M., Mokhele, K., Dakora, F., Veldsman, S. and Wafula, J. 2018. The Future of Science and Science of the Future: Vision and Strategy for the African Open Science Platform. <https://www.nrf.ac.za/sites/default/files/documents/AOSP%20Strategy%20Final%20HR.pdf>

Mwelwa, J., Boulton, G.S., Wafula, J. and Loucoubar, S. 2020. Developing Open Science in Africa: Barriers, Solutions and Opportunities. *Data Science Journal*, 19: 31, pp. 1–17. DOI: <https://doi.org/10.5334/dsj-2020-031>.

Boulton, G.S., Loucoubar, S., Mwelwa, J., Wafula, J., Ozor, N. and Bolo, M. 2020a. Open Science in Research and Innovation for Development in Africa. African Technology Studies Network (ATPS). Research Paper 32, 60pp.

Boulton, G.S., Loucoubar, S., Mwelwa, J., Wafula, J., Ozor, N. and Bolo, M. 2020b The Digital Revolution: Open Science and Innovation for Development in sub-Saharan Africa. African Technology Studies Network (ATPS). Technology Brief 52, 22pp.

13b. Reports for ISC (inc. ICSU)

Boulton G.S. et al. 2015. *Open Data in a Big Data World*. Science International. (International Council for Science - ICSU, International Social Science Council - ISSC, The World Academy of Sciences - TWAS, InterAcademy Partnership - IAP). Paris. <https://council.science/publications/open-data-in-a-big-data-world/>

Boulton, G. 2016. International accord on open data. *Nature* **530**, 281 (2016). <https://doi.org/10.1038/530281c>

Boulton, G.S. 2020. Open Science for the 21st Century. International Science Council report. https://council.science/wp-content/uploads/2020/06/International-Science-Council_Open-Science-for-the-21st-Century_Working-Paper-2020_compressed.pdf

Boulton, G.S. et al. 2021. Opening the Record of Science: making scholarly publishing work for science in the digital era”. International Science Council report.

<http://doi.org/10.5281/zenodo.2222418>

ISC paper in preparation: “Science as a Global Public Good”.