THE ROYAL COMMISSION ON HISTORICAL MANUSCRIPTS

Report on the correspondence and papers of

SIR EDWARD CRISP BULLARD

(1907-1980)

Geophysicist

deposited in

Churchill College Archives Centre, Cambridge

Vol I

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CONTEMPORARY SCIENTIFIC ARCHIVES CENTRE

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Catalogue of the papers and correspondence of

SIR EDWARD CRISP BULLARD FRS

(1907 - 1980)

Compiled by:

Jeannine Alton and Peter Harper

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Deposited in Churchill College Archives Centre, Cambridge

1984

E.C. Bullard
CSAC 100/4/84

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THE ARCHIVIST,
CHURCHILL COLLEGE,
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GENERAL INTRODUCTION

PROVENANCE

The collection, which is very extensive, was received at various dates 1981-84 from Dr. Belinda Bullard (Bullard's eldest daughter) who had assembled it from several locations: Bullard's homes in Cambridge, England, and at La Jolla, California, where he died, his office at the Institute of Geophysics and Planetary Physics (also at La Jolla) and the Department of Geodesy and Geophysics, Cambridge University, where a laboratory now bears his name.

In addition, Lady (Ursula) Bullard made available the sketchbook at A.140; Dr. D.H. Matthews added the photocopied account of the pioneering seismic expedition of 1938 at D.350. The photocopies of the article on Bullard's work on marine heat-flow (A.4) and of his correspondence on the subject with R. Revelle (D.415A) were sent by the Archivist of the Scripps Institution of Oceanography, University of California, where the originals are housed.

OUTLINE OF THE CAREER OF E.C. BULLARD

Bullard was born in 1907 into a comfortable family of Norwich brewers who provided him with relative affluence and a dash of eccentricity. He was educated at Repton and Clare College, Cambridge; his first graduate research was at the Cavendish Laboratory when its Director, from whom he says he learned much, was Rutherford. Bullard himself worked under the direction of P.M.S. (later Lord) Blackett and in collaboration with H.S.W. (later Sir Harrie) Massey, on electron scattering in gases. In 1931, partly because of the economic depression, he accepted a post under Sir Gerald Lenox-Conyngham at the Department of Geodesy and Geophysics in Cambridge; here he worked with great energy and success on a variety of projects: geophysical instrument design and development, gravity determination in Britain and Africa, explosion seismology including the first British expeditions to study the Atlantic seafloor, and heat-flow in South African bore-holes.

During the Second World War Bullard was seconded to the Admiralty, again working on various tasks, including anti-mine protection, operational research and intelligence; at the end of the War he was Assistant Director, Naval Operational Research. Elected to the Fellowship of the Royal Society in 1941 he was a member of the Society's Post-War Needs in Geophysics Committee and instrumental in organising the allocation of surplus equipment and apparatus to universities at the end of hostilities. Returning to Cambridge, he put much effort into re-establishing the Department and its several lines of research, including gravity measurements, heat-flow and deep sea seismic refraction.

In 1947 he accepted a post as Professor of Physics at Toronto, a sudden and many felt an unwise decision which Bullard himself attributed to frustration at the lack of administrative and research facilities at Cambridge. While there, but on a summer vacation visit to the Scripps Institution of Oceanography, he did some of his most important work on the design of equipment for the measurement of heat-flow at sea (in collaboration with A.E. Maxwell), and in 1950 returned to Britain as Director of the National Physical Laboratory. His tenure of this essentially 'establishment' post, which brought him a knighthood in 1953, was remarkable in the amount of research he continued to pursue undistracted - or minimally distracted - by administrative and official duties. He continued to work on marine heat-flow, building apparatus and taking part in sea-going expeditions, and also developed his dynamo theory of terrestrial magnetism.

In 1956 Bullard returned to Cambridge and to the Department of Geodesy and Geophysics as Assistant Director of Research (Reader in Geophysics 1960, Professor 1964). Once again, his research interests proliferated, in collaboration with many gifted students (the 'Cambridge Mariners') to include continental drift and plate tectonics as well as continuing work in seismology and geomagnetism, and a very practical interest in the development of computer programs for processing large amounts of observational data.

During this period too, Bullard was increasingly in demand as consultant and adviser to Government Departments (notably the Admiralty, Foreign Office, Ministries of Defence, Science and Supply), to professional and learned societies such as

the Institute of Physics, the Royal Society and the International Union of Geodesy and Geophysics, and to industrial firms principally Shell and IBM UK of which he was a director for ten years. He was a founder member of the Natural Environment Research Council, played a part in attempts to negotiate a test-ban treaty and was joint chairman of the Anglo-American Ballistic Missiles Committee.

Bullard had always enjoyed his contacts with America where he had many friends. He paid regular visits to various research institutions and was frequently offered tempting appointments. Most of all, he admired the personnel and facilities at Scripps; he accepted from 1963 a Visiting Professorship to spend three months there each year, and on his retirement from Cambridge in 1974 he and his second wife became American residents living at La Jolla. He continued research in geomagnetism and plate tectonics and took part in Scripps expeditions as well as in its teaching and lecturing programmes; and he added a last topic of interest - energy sources and nuclear waste disposal - in his capacity as consultant to the Jet Propulsion Laboratory of Caltech. Despite failing health he remained occupied in writing and research until his death in April 1980.

DESCRIPTION OF THE COLLECTION

The material is presented in the order shown in the List of Contents. The following paragraphs aim only to give a brief guide to its substance and interest; additional explanatory notes accompany many of the Sections, sub-sections and individual entries in the catalogue.

The surviving papers cover almost every aspect of Bullard's career. The chief lacunae in this collection are his wartime papers (see J.7 where Bullard expresses his regret at having destroyed these in 1945) and his official papers at Toronto and at NPL. Despite efforts to assemble as full a collection as possible, there are probably also gaps in the correspondence files, deriving from frequent transatlantic migrations.

Section A includes (A.9) Bullard's own autobiographical notes of his family, childhood and schooldays, written in 1973 and updated in 1980, as well as many tributes by others, some of which have been drawn upon in compiling the catalogue. The

material on his career, though incomplete, yet includes offers of many posts which he declined and which are not always generally known. The 'personal' material includes several items on Bullard's antiquarian book collection (A.185-A.189). Section B is mainly concerned with the Department of Geodesy and Geophysics at Cambridge and includes the original correspondence leading up to its foundation in 1921 (B.1, B.2), and Bullard's efforts to re-invigorate it after the Second World War (B.5-B.29). Section C records his connection with the University of California, chiefly the Scripps Institution of Oceanography. Some of the items deal with his lecturing, teaching and examining there at the end of his life (C.29-C.43); for all his experience as a lecturer he admits in his letters of resignation (C.11) that direct contact with undergraduate work was new to him and he must have been gratified by the unmistable warmth of response he met (C.31, C.34).

Section D (Research) is the largest Section and documents almost all of Bullard's many research interests, some more comprehensively than others. It is remarkable to see the extent of manuscript notes, calculations, diagrams, site descriptions, drafts and, later, computer programs all in Bullard's hand whether written in the African field, as Director of NPL or as Professor of Geophysics at Cambridge. Especially full are the records for gravity measurement including the famous 1933-34 expedition to East Africa, for heat-flow research including the 1938 Atlantic expedition, and for the work on dynamo theory and on computing applications. His last research, on energy sources and nuclear waste disposal, is also documented, and includes drafts for a book on the subject on which Bullard was working right up to his death. Less fully represented in the surviving papers is Bullard's contribution to the theory of continental drift and plate tectonics. Of more general interest is D.273, Bullard's detailed account of (it seems) every penny spent on the 1933-34 expedition in East Africa. The famous story of his being treed by lions, however, is not recorded: there is a reference to his 'experiences with lions' in a letter (at D.366) but this is dated January 1939 and refers to a later trip to South Africa to study terrestrial heat-flow. In sum, this Section provides an impressive record of Bullard's distinguished research career; he may have borne his learning lightly but its presence is irrefutable.

Sections E and F document Bullard's public life as consultant, committee member and adviser on science policy. Because of the confidential or official nature of much of this work, the surviving material is sometimes sparse. Section G includes

several unpublished, or unlisted, works, among them substantial drafts for a book on optics, in collaboration with P.B. Moon, commissioned by Cambridge University Press in 1934 (G.2-G.18). There is also a rather full record of Bullard's joint editorship with N.F. (Sir Nevill) Mott of the International Monographs in Physical Science for the Clarendon Press (G.194-G.230). The sub-section on 'Lectures' (G.138-G.175) is of interest in showing at once Bullard's mastery of his subject and the temperamental poise, even panache, which enabled him to lecture with rivetting success on the basis of half a page of notes.

Both Sections H and J are somewhat disappointing in that it is unlikely that they represent more than a selection of Bullard's visits and conferences (H) and correspondence (J). The latter Section contains a high proportion of material dating from his later years when he was frequently consulted by historians of several disciplines for his recollections and opinions.

Bullard's historical interests were not confined to the events of his own career, though it is true that he was at pains to collect material about the early history of the Cambridge Department (Section D) and Bushy House his official residence as Director of NPL (Section A). But he was a respected collector of scientific books, with a special interest in Newton and Halley; he played an important role in the Royal Society's Halley Tercentenary celebrations (Section G), advised the Institute of Physics on the disposal of its historical book collection (Section F) and presented a scion of Newton's apple tree for planting at the new buildings of the Cambridge Department (Section B). He wrote several biographical tributes and accounts of colleagues; the most substantial of these is perhaps the memoir of W.M. Ewing, while a more 'light-hearted' (his description) account of Rutherford published originally in NATURE was selected for quotation in L. and H. Fowler, Cambridge Commemorated, 1984.

Bullard was held in almost universal esteem and affection, which transpires throughout the collection, whether in the flood of requests to visit, lecture, or advise on technical matters, the many offers of influential posts in Britain and America, the trust placed in him as adviser, referee and consultant at every level from national academies and government ministries to junior employees and sixth-formers, or the more 'objective' criteria of 'Course and Professor Evaluation' (at Scripps) and BBC audience research panel reports. One can see why. Bullard - known and addressed

by all as 'Teddy' - seems to have grown younger and less formal as his age and honours increased. Even without his voice and living presence, his personality emerges unmistakably in all he wrote: serious without pomposity, forthright without animosity, loyal without prejudice. He rarely lost contact with old friends and colleagues and often intervened quietly to help them or their families left unprovided for by death or inadequate pensions (a topic on which he felt strongly). He appears never to have written a routine letter; he may (as he often claimed) have never quite mastered English spelling conventions, but his thought and his wit are immediately accessible.

In view of the very full and frank nature of some of the documents it will readily be understood that they are not all currently available for consultation. Material of this kind occurs in Sections A, C, E, F, G and J.

LOCATIONS OF FURTHER MATERIAL

Certificates and scrolls of honour remain in family hands.

Material relating to the Anchor Brewery (the Bullard family firm) is held at the Norfolk and Norwich Record Office.

Material assembled by Bullard for his memorial writings on W.M. Ewing is at Columbia University, New York.

Correspondence exchanged with W.H. Munk and others is in the Archives of the Scripps Institution of Oceanography, University of California, San Diego.

Official papers relating to Bullard's service on government committees are held at the Air Historical Branch, Ministry of Defence.

ACKNOWLEDGEMENTS

Our main debt is to Dr. Belinda Bullard for her initiative in assembling material, her encouragement, and her comments on the draft catalogue.

We are also indebted to:

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SECTION A BIOGRAPHICAL AND PERSONAL A.1 - A.261

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SOME OF THE MATERIAL IN THIS SECTION MAY BE SUBJECT TO RESTRICTION

Biographical and personal

A.1-A.14 BIOGRAPHICAL, AUTOBIOGRAPHICAL, BIBLIOGRAPHICAL

BIOGRAPHICAL ACCOUNTS OF BULLARD AND HIS WORK

A.1 'Profile', New Scientist, 1959.

Biographical note and list of Bullard's publications, by M.N. Hill, 1962, with ms. note 'originally written for R.S. Profship'.

Biographical note, for Scripps Institution, 1970. Includes tables of Bullard's salaries from 1931.

'Sir Edward Bullard', by D. Davies, Earth-Science Reviews, 1968 (Photocopy).

A.2 1p. biographical note, 1971.

Revised Who's Who entry, 1975.

Newspaper article, 1977.

A.3 'Sir Edward C. Bullard', 3pp. note, January 1978.

Obituary and Memorial Service notices, The Times, 1980.

Memoir by W. Nierenberg and R. Revelle.

'Imagined Worlds: The Day the Earth Moved', by D. McKenzie (on plate tectonics), The Listener, 1982.

AUTOBIOGRAPHICAL

A.4 'E.C. Bullard's First Heat-Probe'

Article by E.N. Shor, incorporating shortened version of a taped conversation with Bullard on 5 August 1973, published in EOS, 28 February 1984.

(Photocopy kindly made available by the Archivist, Scripps Institution of Oceanography.)

A.5 Note for McGraw Hill Modern Men of Science, c.1966 (on work on the origin of the earth's magnetic field).

Later extended note for McGraw Hill and for Monadori Editore, 1979.

A.6 Correspondence with both publishing houses, 1972-78.

Biographical and personal

A.7 'Edward Bullard'. Dedication by W.H. Munk for 'Topics in Non-Linear Dynamics' (Bibliog. 1978a).

19pp. ms. draft (photocopy).

4pp. typescript version as published with a ms. note 'This was written entirely by me. ECB 3-30-78'.

A.8 Interview for Oral History Department, United States Naval Institute.

Correspondence, 1969-70, and corrected typescript transcript of interview conducted during Symposium Oceanography 2000, including reminiscences of much of Bullard's research career. 45pp.

A.9 'Notes for Biographical Notice of Edward Bullard'.

36pp. ms. account of family, early life and schooldays up to and including Repton. Written 1973, with 1p., 6 March 1980, and sent to the Royal Society with a covering letter re his biographer, 31 March 1980 (Bullard died on 3 April).

Included in the folder are a few additional notes, family trees, etc.

A.10 Miscellaneous autobiographical notes by Bullard.

Includes lists of children's and grandchildren's birthdays, of wartime colleagues, of his addresses 1921-75, of his research notebooks, of his proposed periods of residence at La Jolla, etc.

A.11 A selection of letters written by Bullard in response to enquiries or requests for his views on various topics. Similar material may be found elsewhere, particularly in the correspondence section where an indication is given, but these offer a compendious insight into Bullard's characteristic approach.

They include letters on the value of interchange with overseas students (1967), on the Rothschild Report (1971), on pension schemes (1976), and on combining research and administration (1977) - this last being of special biographical interest.

Biographical and personal

BIBLIOGRAPHICAL

A.12 List of publications.

27pp. (variously paginated) typescript with ms. additions, made available by B. Bullard, 20 July 1983. It is reproduced on pp. 311-337.

This is the bibliography used in the attribution of publications, drafts and research material in the manuscript collection, in the form (Bibliog ...) appended to the relevant entries.

A.13 Copies, or photocopies, of papers selected by Bullard as of special interest, and bearing his own ms. comment. Sent to the Director, Scripps Institution, 12 May 1975, with a covering note as follows:

'This selection of my papers attempts to give a cross-section of the things about which I have written, I have not attempted to select the "most important" papers.

The papers are:

'Work of H.S.W. Massey and E.C. Bullard on electron scattering', 4pp. typescript and ms. account by Bullard, n.d.

This item was added to the selection at a later date, probably 1978. See J.10, J.91.

'The Elastic Scattering of Slow Electrons in Argon', (Bibliog. 1931a), with comment 'Work done while a graduate student. Experimental Atomic Physics'.

'The protection of ships from magnetic mines', (Bibliog. 1946a), with comment 'An account of work during the war'.

'The flow of heat through the floor of the Atlantic Ocean', (Bibliog. 1954c), with comment 'Experimental work at sea'.

'Homogeneous dynamos and terrestrial magnetism', (Bibliog. 1954e), with comment 'A long and rather complicated theoretical paper on the origin of the earth's magnetic field'.

Continued

Biographical and personal

A.13 (Cont'd.)

'Continental drift', (Bibliog. 1964b), with comment 'An attempt to persuade the geological establishment of the error of their beliefs - it was successful beyond my expectation'.

'Reversals of the earth's magnetic field', (Bibliog. 1968a), with comment 'Review to a high-level audience of a critical part of the evidence for the recent revolution in geological thought'.

'The origin of the oceans', (Bibliog. 1969b), with comment 'A popular exposition - it has sold 180,000 copies (in addition to its original sales in the Sci.Amer.)'.

'Electromagnetic induction in the oceans', (Bibliog. 1970a), with comment 'Systematic review and development of a relatively new branch of geophysics'.

'Basic theories', (Bibliog. 1973b), with comment '1st chapter in a UNESCO book on Geothermal Power, relates the problems to the scientific background'.

'Rutherford's Cavendish', (Bibliog. 1974b), with comment 'A light-hearted historical work'.

'Minerals from the deep sea', (Bibliog. 1974c), with comment 'Possible source of base metals in the ocean'.

A.14

Miscellaneous lists of names and addresses for reprint distribution, for various periods of Bullard's career; some very early, and continuing to 1978.

Miscellaneous lists of publications, compiled for bound volumes and for various occasions (to 1973).

Biographical and personal

A.15-A.47 DIARIES

These are all small pocket diaries. They form a relatively complete sequence, 1942-78, though some are scantily used. Diaries for 1951 and 1955 are missing.

A.15	1942-43	A.19	1947-48
A.16	1943-44	A.20	1949
A.17	1945	A.21	1949-50
A.18	1946-47		

A.22	1952 (hardly used)	A.26	1956
A.23	1952 (hardly used)	A.26A	1957
A.24	1953	A.27	1958
A.25	1954	A.28	1959

A.29	1960	A.34	1965
A.30	1961	A.35	1966
A.31	1962	A.36	1967
A.32	1963	A.37	1968
A.33	1964	A.38	1969

A.39	1970	A.44	1975
A.40	1971	A.45	1976
A.41	1972	A.46	1977
A.42	1973	A.47	1978
A.43	1974		

Biographical and personal

A.48-A.123 CAREER, HONOURS AND AWARDS

A.48 Two letters from Bullard to his mother, one dated 1917, the other '?1916'.

A.49 Repton School Reports 1924-26. The English master describes Bullard as 'a willing worker, with no literary tastes'.

Includes letter, January 1924, to Bullard's father from the Headmaster (G.F. Fisher).

A.50 Mathematical Tripos and Natural Sciences Tripos Part I Examination Papers, annotated by Bullard, May-June 1928.

Included here is a reprint of a paper by H. McCombie et al, February 1928, acknowledging work 'carried out by Mr. E.C. Bullard, of Clare College, in the Mineralogical Museum'.

A.51 Certificate of election, Fellow of the Royal Astronomical Society, December 1931.

Superannuation Agreement on appointment as Demonstrator in Geodesy, 1932.

Correspondence re possible appointment at Carnegie Institution of Washington, 1933.

A.52 Two letters to Bullard's parents, 1933, on his impending trip to Africa.

A.53 Miscellaneous correspondence on career.

Includes letter re Pembroke College, Cambridge, 1935.

Bullard's draft letter re Chair of Physics at Cape Town, 1936.

Correspondence re Smithson Research Fellowship of the Royal Society, appointment 1935, move to Admiralty 1939, extension 1942.

Biographical and personal

A.54 Correspondence, 1941 and 1943, re Chairs at Liverpool.

Letter of congratulation on election to Royal Society, 1941 (only surviving letter).

A.55 Miscellaneous items re service in Second World War.

Includes material re staff and salaries, invitation to serve on Physics Committee, Advisory Council on Scientific Research, Ministry of Supply, 1944, and on Scientific Research Advisory Committee, Ministry of Labour, 1945.

A.56 Cambridge University, 1943-46.

Includes material re Bullard's Readership, his release from war service, arrangements for I.C.I. Fellowships, etc.

Also included is letter of appointment as External Examiner in Physics, Manchester, 1945.

A.57 Clare College, Cambridge, 1943-45.

Includes correspondence re election to Research Fellowship, 1943, and Official Fellowship, 1945, and miscellaneous items on teaching and examinations.

A.58 Correspondence, 1947, re post of Director of Safety in Mines Research.

For offer of post at Institute of Geophysics, Los Angeles, see J.133.

A.59-A.61 Appointment as Professor of Physics, Toronto.

A.59 Correspondence and negotiations, 1947, including letter of appointment with effect from 1 March 1948.

A.60 Correspondence re staffing and funding of UK Physics Departments, sent at Bullard's request by N.F. Mott, W.L. Bragg, 1949.

A.61 Correspondence, 1949, re Bullard's resignation.

Biographical and personal

A.62 Correspondence, 1948, 1949, re possible appointments at Cambridge.

For correspondence re the offer to Bullard of the post of Director of the Scripps Institution, see C.14.

A.63-A.77 Appointment as Director, National Physical Laboratory (NPL).

See F.39-F.49 for NPL material after Bullard's resignation as Director.

See A.241-A.246 for photographs of NPL occasions.

A.63 Letters and cables re appointment.

Includes letters of appointment, press-cuttings.

A.64-A.70 Letters and cables of congratulation.

A.64	A - B	A.68	S - T
A.65	C - F	A.69	V - W
A.66	G - L	A.70	First name and unidentified signatures
A.67	M - R		

A.71 Correspondence and accounts, mainly with Royal Society, re payments from the Petavel fund for expenses of furnishing and entertaining at Bushy House (residence of the Director, NPL). Includes detailed ms. accounts of expenditure claimed by Bullard, 1950-55.

A.72-A.76 Material relating to the history of Bushy House.

A.72 Notebook inscribed 'References to Bushy House'.

A.73 4pp. notes and references from State Papers, 1689-1695.

Biographical and personal

A.74 Bundle of index cards of references, 1621-1864/5.

A.75 3pp. note on Bushy House, no author, 1932.

Correspondence re early owners of Bushy House, 1952, 1962.

A.76 Correspondence on Bushy House, 1962, 1970, 1980.

A.77 Invitation (declined) to serve on Visiting Board of NPL, 1976.

A.78 Warrant of appointment, Board of Visitors, Royal Greenwich Observatory, 1953.

A.79 Correspondence and negotiations re return to Cambridge, 1953-54.

A.80 Correspondence re election to Berkeley Bye-Fellowship, Caius College, Cambridge, and resignation from NPL, January-July 1955.

A.81 Correspondence re appointment as Senior Assistant in Research, Department of Geodesy and Geophysics, November-December 1955, and one letter 1956.

A.82 Correspondence, 1955, re proposed research at Cambridge.

A.83 Offer (declined) of 'Institute Professorship' to head new Laboratory of Earth Science, Massachusetts Institute of Technology, 1958.

A.84 Miscellaneous honours, 1959.

Award of Arthur L. Day Medal of Geological Society of America for 1958.

Election as foreign associate, National Academy of Sciences, 1959.

Biographical and personal

A.85-A.87 Churchill College, Cambridge.

Bullard was a Professorial Fellow from 1960, and a 'Pensioner Fellow' on his retirement in 1974. The correspondence refers to general academic and social affairs of the College.

3 folders as follows:

A.85 1960-73

A.86 1974 Includes Bullard's letter of resignation from College committees, and material re the Bullard Prize set up to mark his retirement and awarded to the Churchill undergraduate achieving the highest marks in Physics in the Natural Sciences Tripos.

A.87 1975-78.

A.88 Correspondence re Headships of Colleges at Oxford and Cambridge, 1960, c.1966, 1968.

Offer of Professorship at Yale, 1960 (declined).

A.89-A.91 University of East Anglia.

Bullard served on the Court of the University, and received an Honorary D.Sc. in 1976.

3 folders as follows:

A.89 1961, 1970. Includes material re University's decision to bank elsewhere than at Barclays Bank.

A.90 1974-76. Includes material re Bullard's Honorary Degree, originally proposed for 1975 but deferred until 1976.

A.91 1976-79.

Biographical and personal

A.92-A.94 The Vetlesen Prize.

The prize was established in Columbia University in 1959 by the G. Unger Vetlesen Foundation (itself set up in 1955). It is awarded for 'achievement in the sciences of the earth and the universe', the first recipient being W.M. Ewing. Bullard regularly attended the presentation meetings and made recommendations, and was himself awarded the prize, with F. Birch, in 1968. See especially A.93 below.

3 folders as follows:

A.92 1962. Award Dinner for H. Jeffreys and F.A. Vening Meinesz.

A.93 1968. Award to Bullard and F. Birch. Includes notification, letters of congratulation, ms. note of Bullard's speech of thanks at dinner, 8pp. draft of his lecture at the symposium, publication arrangements, 14pp. revised version, printed information re Vetlesen, Foundation and prize, etc.

The letter of notification (11 October 1968) explains the history of the prize which it was intended would 'in time ... rank in dignity and significance with the Nobel Prizes which now recognise scholarly and scientific achievement in other fields'. See also C.24.

A.94 1970, 1971.

A.95 Award of Alexander Agassiz Medal, National Academy of Sciences, 1965.

A.96 Award of Wollaston Medal, Geological Society of London, 1967.

Correspondence, press notice, draft of Bullard's remarks on receiving medal.

A.97 Election as Honorary Fellow, Indian Geophysical Union, 1967.

Biographical and personal

A.98 Invitation to University of Toronto as Centennial Visiting Professor in 1967.

Brief correspondence, 1966-68. See also G.157.

A.99 Correspondence, 1968-69, re offer to Bullard of newly-created Henry L. Doherty Chair, Woods Hole Oceanographic Institution, Massachusetts.

A.100 Correspondence, 1969, re Election as Foreign Member, American Philosophical Society.

A.101 Certificate of Commendation, Committee on Oceanography, Texas House of Representatives, 1970 (Bullard's letter only).

A.102 Election to Mark Twain Society, 1971 and 1976.

A.103 Conferral of honorary D.Sc., Memorial University of Newfoundland, 1971.

Correspondence, programme, etc.

A.104 Honorary Membership, Stokes Society, Cambridge, 1972 (correspondence only).

A.105 Honorary Fellowship, Geological Society of India, 1972 (correspondence only).

A.106 Retirement from Cambridge, 1974.

Letters and cables of greeting, signatures of those attending retirement dinner at King's College, Bullard's notes for speech.

A.107 Correspondence re honorary degree, Leicester University, 1974.

A.108 Correspondence re honorary membership, European Geophysical Society, 1974.

Biographical and personal

A.109 Correspondence re offer to Bullard of Directorship, Marine Science Institute, University of Texas at Austin, 1974. Bullard declined, preferring to retain his connection with Scripps.

A.110-A.114 The Royal Medal, 1975

A.110 Notifications, citation, arrangements for award of medal, press-cuttings.

A.111-A.114 Letters and cables of congratulation.

A.111 A- B

A.112 G - N

A.113 R - S

A.114 V - W and unidentified.

A.115 Award of the William Bowie Medal, 'for outstanding contributions to fundamental geophysics and for unselfish cooperation in research', 1975. See also F.3.

Includes photocopy of Bullard's 'Reply on receiving the Bowie Medal'.

A.116 Midsummer Banquet, Mansion House, London, 1976.

A.117 Caius College, Cambridge.

Re-election to Combination Room, 1978.

A.118 The Ewing Medal, 1978.

Bullard was not able to receive the Medal in person; the item is his 'Response on receiving the Ewing Medal'. See also F.4.

Biographical and personal

A.119-A.121 'A Meeting in Honor of Sir Edward Bullard', held at Scripps Institution of Oceanography, 11 and 12 January 1980.

The papers were published in the Journal of Geophysical Research, 1981, 86, pp.11509-11695.

The meeting was sponsored by:

Cambridge University
Massachusetts Institute of Technology
The Office of Naval Research
Scripps Institution of Oceanography
The University of Miami
Woods Hole Oceanographic Institute

The range of sponsors and of the topics discussed (A.119) indicate the breadth of Bullard's research interests. The letters from friends (A.120) and Bullard's letters of thanks to the organisers (A.121) show the affection in which he was held and his own pleasure at what was tacitly recognised as a farewell.

A.119 Programme, list of participants.

A.120 Letters and cables from friends.

A.121 Bullard's letters of thanks to A.E. Maxwell and W.A. Nierenberg (photocopies).

A.122 Programmes of lectures, symposia and conferences given, organised or attended by Bullard.

A.123 Miscellaneous press-cuttings of Bullard, career, activities, honours.

Biographical and personal

A.124-A.205 FAMILY AND PERSONAL

A.124-A.148 The Bullard family

A.149-A.157 Personal correspondence

A.158-A.205 Miscellaneous biographical material

A.124-A.148 The Bullard family

A.124 Certificates (or copies) of Bullard's birth, marriage, divorce, second marriage.

A.125 Correspondence, mainly with solicitors, about the estates of Bullard's father (Edward John, d. 1950) and mother (Eleanor Howes Bullard, d. 1962). Correspondence runs 1950-66 and is in large part concerned with the affairs of Bullard and Sons, the family brewery in Norwich. See below.

A.126 Short account of the 'Anchor Brewery', the family firm founded in 1837. Bullard became a director in 1952 and continued as such until the firm was taken over by Watney Mann in 1964.

6pp. typescript, August 1955.

This is a photocopy of the original document which has been deposited, with other material relating to the firm (1951-68) at the Norfolk and Norwich Record Office where earlier records of the firm are already held.

A.127 Correspondence and papers exchanged with Watney Mann, 1970-71.

Mainly about data processing systems and including a report by Bullard after a visit to Watney Mann computer centre at Brighton; also includes correspondence and papers on the effect of weather on beer consumption.

Biographical and personal

A.128 Sir Harry Bullard (Bullard's grandfather, M.P. for Norwich, d. 1902).

Mainly correspondence about estate (1955-57) but includes some reminiscences by Bullard in response to an enquiry (1974).

A.129 Sir Frank Crisp (Bullard's grandfather).

Mainly correspondence from Bullard's sister, Molly, about Friar Park, the house at Henley built by Crisp and bought (1970) by George Harrison of the Beatles.

A.130-A.133 Margaret Ellen (Tom) Bullard, Bullard's first wife (m. 1931, marriage dissolved 1974).

See Section D passim for Margaret Bullard's active participation in various research projects in the 1930s and early 1940s.

The surviving correspondence dates from the later and less happy years when the marriage was under strain. Very few of Margaret Bullard's letters are dated and in the absence of postmarks they are placed in a tentative order based on context.

A.130 1954, 1962, 1965, 1967 and one unidentified letter to Margaret Bullard 1934. Includes post-card from Bullard, 1941 (after raids on Portsmouth).

A.131 1968 (approx.)

A.132 1971-73 (approx.)

A.133 1973-76

A.134 Emily (Stewart) and Henrietta (Bullard's twin daughters).

Brief correspondence, 1960s and 1970s.

Biographical and personal

A.135-A.137 Polly (Hill), Bullard's youngest daughter.

Very few of these letters are dated. They run approximately 1966-79, in three folders.

A.138 Notes and letters from Bullard's grandchildren.

A.139, A.140 Ursula Margery Bullard (formerly Curnow, née Cooke, Bullard's second wife).

A.139 Miscellaneous shorter correspondence.

A.140 Drawing book, containing two drawings of Arthur, son of Belinda Bullard (Bullard's eldest daughter) by Odile Crick, and 7 drawings of Bullard in his last illness, 2 April 1980, by Ursula Bullard. Made available by Lady Bullard, 1982.

A.141 Miscellaneous correspondence with other members of the Bullard family, or others of the same name, some including reminiscences or biographical information.

A.142-A.145 19 Clarkson Road, Cambridge (Bullard's home, now occupied by Belinda Bullard).

Miscellaneous correspondence about purchase, heating, various lettings of the house, 1954-75.

In his letter of 21 June 1955 Bullard states that the house was built for him in 1935.

A.142 1950, 1954-57.

A.143 1955 (Bullard's drawings and specifications).

A.144 1968-75.

A.145 Miscellaneous correspondence with Belinda Bullard, 1970-76, on various matters, including transfer of the lease of the house in 1974.

Biographical and personal

A.146-A.148 Correspondence with solicitors (Francis & Company, Cambridge), on various family matters, wills, trusts for children and grandchildren, divorce settlement, etc.

A.146 1962-71. Wills and settlements.

A.147 1973-74. Mainly divorce petition, and transfer of lease of house.

A.148 1974-77. Wills and settlements.

Biographical and personal

A.149-A.157 Personal correspondence

These are all letters from female friends, most of very long acquaintance. Few of the letters can be dated except when there is a postmark, and some are signed with first names only.

A.149, A.150	G	1940-74
A.151	I - K	
A.152	L - M	
A.153	R	
A.154	S	1953-76
A.155	S	1950-79
A.156	T	1955-80
A.157	Miscellaneous cheques.	

Biographical and personal

A.158-A.205 Miscellaneous biographical material

A.158-A.177 Finance and Investments in Britain.

A.158-A.164 Correspondence with accountants on UK Income Tax. Includes statements of income and expenses prepared by Bullard and by accountants.

The accountants were Down, Kilner & Company (correspondence: W.R. Packer) until 1 May 1971, and thereafter Buzzacott, Vincent, Watson, Kilner & Company (correspondence: Thomas Kilner).

A.158	1961-64
A.159	1965-67
A.160	1968-69
A.161	1970-71
A.162	1972-73
A.163	1974
A.164	1975-80

Biographical and personal

A.165-A.171 Correspondence with N.M. Rothschild & Sons.

Rothschilds took over the management of Bullard's investments at his suggestion from June 1967 (see letters May-June 1967 in A.165) actively maintaining his portfolio, keeping capital, income and deposit accounts and transferring monies to and from his bank accounts as requested.

The material includes transfer certificates, balances of accounts and general correspondence on the management of funds.

A.165 1967

A.166 1968

A.167 1969-70

A.168 1971-72

A.169 1973. Includes statement of holdings as at 31 December 1973.

A.170 1974-79

A.171 Miscellaneous statements of accounts with Rothschilds.

A.172 Correspondence, 1975-79, with National Westminster Bank concerning transfer of funds on Bullard's and Lady Bullard's becoming U.S. residents.

A.173 Shorter correspondence re U.K. pension, 1975-80.

A.174 Correspondence re possible participation in Lloyds syndicate, 1971-74.

Biographical and personal

A.175 Miscellaneous shorter notes and correspondence on financial matters, various dates, 1956-79.

A.176 Miscellaneous royalty statements, broadcast and TV fees.

A.177 Miscellaneous college and university fees, thesis supervision and examining.

Bundle of dividend warrants, chiefly Bullard & Sons.

A.178-A.184 Finance and Investments in U.S.A.

A.178 Correspondence with accountant (George A. Peterson) on U.S.A. income tax and financial matters, 1962-78 (not all complete).

A.179 Correspondence and papers re Lux Land Company, Brawley, California. Bullard was a 'Limited Partner'. See also R. & R. Land and Cattle Company. 1965-74.

A.180 Correspondence and papers re Universal Resources (a California estate company), 1969-73.

A.181-A.184 Correspondence and papers re R. & R. Land and Cattle Company, Brawley, California. Bullard was a 'Limited Partner'. See also Lux Land Company.

A.181 1970-73

A.182 1974-76

A.183 1979

A.184 Plans of ranch holdings and land improvements, mainly 1972.

Biographical and personal

A.185-A.189 Books.

Bullard had collected books on science and on the history of science since student days, with a special interest in Halley. He bought at auction and from dealers, many of whom came to respect his knowledge and to consult him on certain items.

See G.123-G.133 for Bullard's contribution to the Halley Tercentenary.

See also F.21.

A.185 Correspondence with Dawsons of Pall Mall, 1960-79.

A.186 Miscellaneous correspondence on books and book purchases, 1965-77.

A.187 Similar, 1978.

A.188 Similar, 1979.

A.189 Miscellaneous notes and lists of books and book purchases by Bullard. Includes notes for a talk on 'My Books' given at San Diego, February 1977, describing his interest and collection.

Photocopy of Bullard's catalogue of his books, some with notes of dates of purchase and prices.

Biographical and personal

A.190-A.194	Health
A.190	1943-49
A.191	1968-72
A.192	1973-74
A.193	1975-78
A.194	1979

A.195	Miscellaneous birthday, greeting, get-well cards, 1970s.
A.196	Miscellaneous memos., lists, engagement plans drawn up by Bullard.
A.197	Correspondence re portraits, photographs and interviews with Bullard. Includes correspondence, 1972-73, with Ruskin Spear about the retirement portrait now at the Cambridge Department. 1959-77.
A.198	Miscellaneous humorous anecdotes, drawings, quotations collected by or sent to Bullard.
A.199, A.200	Miscellaneous correspondence, notifications, etc. of societies and appeals. Several of these are requests to sign Test Ban on Disarmament appeals.
A.199	1961, 1970-73
A.200	1974-79

Biographical and personal

A.201 Letters of congratulation sent by Bullard to colleagues receiving honours and awards. Mostly Bullard's carbons only, but some with replies. 1960-79.

A.202 Letters of thanks to acknowledge books, articles, photographs, etc. received by Bullard.

A.203 Shorter correspondence on social invitations, 1966-73 (only).

A.204 Miscellaneous items, including results of I.Q. test (1952), speeding fines, wine merchant (Bullard sent regular gifts of wine to his doctors).

A.205 Miscellaneous items of personal correspondence, various dates. Includes letter recalling Bullard's childhood in Norwich, letter from wartime colleague at Portsmouth, etc.

Biographical and personal

A.206-A.257 PHOTOGRAPHS

A.206-A.214 Photographs of Bullard

A.215-A.218 Family and personal friends

A.219-A.233 Conferences and groups

A.234-A.239 Scientific colleagues

A.240 Second World War

A.241-A.246 National Physical Laboratory

A.247-A.257 Expeditions and research

A.206-A.214 Photographs of Bullard

A.206 At National Physical Laboratory. Includes a photograph of the portrait of Bullard by Bernard Dunstan at NPL.

A.207 Lecturing at Royal Institution, c.1954.

A.208 Watching solar eclipse, with Chapman Pincher, n.d.

A.209 Miscellaneous photographs, some with dates in 1950s.

Biographical and personal

A.210 Photograph labelled by Bullard on verso: 'ECB with apparatus for measuring heat flow through the floor of the ocean. Taken in 1953 ...'.

Photograph inscribed 'NPL, British Ass. visit to ICI salt mine'.

A.211 At home.

A.212 Later photographs, including some late portraits at Alaska, 1978, 1979.

A.213 Set of 4 photographs, one labelled 'Lux Ranch'. 1970s.

A.214 Portrait study photograph.

A.215-A.218 Family and personal friends

A.215 Of Ursula Bullard.

A.216 On safari in Kenya, 1968.

A.217 Envelope of miscellaneous photographs of friends, a few only named and dated.

A.218 Humorous drawing of 'The BOMM bomber'.

A.219-A.233 Conferences and groups

A.219 Group photographs of the Cambridge Department, 1930s (with Lenox-Conyngham), 1960s.

A.220 Seventh General Assembly, I.U. Geodesy and Geophysics, Washington D.C., September 1939 (2 copies).

Biographical and personal

A.221 Dallas, 1955.

National Bureau of Standards, 1955.

A.222 Anglo-U.S. ballistic missiles committee, Los Angeles, 1956.

A.223 Geneva conference on nuclear tests, 1958.

A.224 Set of photographs of visit to U.S. Air Base (probably Anglo-U.S. missiles committee, 1959).

Press Conference on 'Space', c.1958.

A.225 First Major International Congress on Oceanography, United Nations, New York, 1959. Includes R. Revelle, W.M. Ewing.

A.226 Vetlesen Lecture, 1960.

Earth Tide Symposium, Brussels, 1961.

A.227 Second International Oceanographic Congress, Moscow, 1966.

A.228 Churchill College, Cambridge.

Inauguration photograph.

Photograph of Bullard with Lord Home.

A.229 IBM Conference at Churchill College, 1967.

A.230 Symposium on Earth's Magnetic Field, Washington D.C., 1968.

Opening (by Bullard) of Geomagnetic Research Laboratory, Newfoundland, 1971.

A.231 Bullard with astronauts, at Cambridge, 1971.

Biographical and personal

A.232 Alaska, n.d.

Conference at Princeton, 1972 (with Walter Sullivan).

Penn. State, 1976.

A.233 Unidentified. Loose photographs and a commemorative album from Rocketdyne (aviation company).

A.234-A.239 Scientific colleagues

A.234 Early Cambridge days.

Includes copies of photographs of Rutherford and J.J. Thomson; photograph of Bullard with G.I. Taylor, 1938; miscellaneous photographs at Cavendish, 1930s.

Small photograph of Bullard with B.J. Schonland (perhaps in Africa, c.1938).

A.235 Sir Gerald Lenox-Conyngham.

Sir Harold Jeffreys.

A.236 M.N. Hill.

A.237 Set of photographs taken at the Royal Society, London, on the occasion of the award of the Vetlesen Prize Medal to A. Holmes, 1964. (The presentation was made by W.M. Ewing.)

A.238 J. Miller, 1960.

L. Szilard, 1965, and Trude Szilard, 1970.

T.F. Gaskell, 1970.

M. Prior.

Biographical and personal

A.239 Miscellaneous other photographs, including NATO conference, historical photograph of Einstein and von Neumann, Bullard with Blackett and others.

A.240 Second World War

Set of photographs, only one dated 'Clarence Pier 1940', but all of same period, recording the devastation caused by fire after an air raid. The mine-sweeping apparatus was destroyed and consequently Bullard and the team moved to Edinburgh.

A.241-A.246 National Physical Laboratory

A.241 The Pilot ACE.

A.242 Visit by H.R.H. Prince Philip.

A.243 Visit by The King and Queen of Sweden.

A.244 Visitors to the High Voltage Laboratory.

A.245 Various NPL occasions. Includes Coronation exhibition lorry (with Polly Bullard), opening of NPL auditorium, start of work on Ship Tank, presentation of Bullard's portrait, Bullard with staff of Physics Department.

A.246 Informal NPL occasions, sports days, garden parties, etc.

A.247-A.257 Expeditions and research

A.247 Photograph labelled 'Fishing a large net from the Discovery II May 1937' (photograph is a later copy).

Biographical and personal

A.248 Set of photographs taken in H.M.S. Tudor, July 1946, during the Royal Society submarine gravity survey of the eastern North Atlantic. Includes equipment, colleagues (B.C. Browne, R.I.B. Cooper, W. Niewenkamp).

A.249 Set of photographs of work on marine heat flow, 1949. Includes equipment and apparatus, research vessel 'E.W. Scripps', A.E. Maxwell with probe, etc.

A.250 Envelope of photographs (small format) of equipment, colleagues, etc. on 'Discovery' expeditions, none dated but some identified on verso (Hill, Gaskell, Cleverley, Swallow, etc.).

A.251 Miscellaneous photographs, similar material, of 'Discovery' equipment, colleagues and crew, etc., n.d. 1950s.

A.252 Photographs of heat flow probe, many taken by NPL. n.d. 1950s.

A.253 Miscellaneous expedition photographs, some with various dates, 1958-64.

A.254 Miscellaneous photographs of expedition to Fiji, Easter Island and South Pacific, 1967.

A.255 Miscellaneous photographs (small format) of later expedition, n.d., 1970s.

A.256 Miscellaneous photographs of research vessels, equipment and apparatus. None dated.

A.257 Miscellaneous photographs of expeditions and apparatus, taken by Scripps Institution or other U.S. sources.

Biographical and personal

A.258-A.261 TAPE RECORDINGS

A.258, A.259 Two lectures at Berkeley, 1975.

A.258 'The Floor of the Deep Oceans - What Are They Like?' 20 January.

A.259 'The Floor of the Deep Oceans - What Is Happening There?' 3 February.

See H.20

A.260 'Physics and W.W.II', given at Berkeley 1976 (cassette).

A.261 'Scientific advice to government. Lect.7' dated 3/4/76 (cassette).

See G.167 for transcript of the lecture.

SECTION B CAMBRIDGE B.1 - B.92

B.1-B.88 DEPARTMENT OF GEODESY AND GEOPHYSICS

B.1 -B.4 Early history of the Department

B.5 -B.29 Postwar organisation and research, 1943-48

B.30-B.73 Research and administration, 1956-80

B.74-B.88 Lectures

B.89-B.92 OTHER CAMBRIDGE DEPARTMENTS/INSTITUTIONS

For biographical material on Bullard's career at Cambridge, his colleges, home and interests, see Section A, passim.

For material on research projects at or connected with Cambridge, see Section D, passim.

Cambridge

B.1-B.88 DEPARTMENT OF GEODESY AND GEOPHYSICS

B.1-B.4 EARLY HISTORY OF THE DEPARTMENT

The early material appears to have been inherited by Bullard from Sir Gerald Lenox-Conyngham, either directly or via B.C. Browne.

B.1 Tagged folder of correspondence and papers, inscribed 'British Association Geodesy Committee/Correspondence 1916-1919 relating to the Establishment of a Geodetic Institute in Britain'.

The British Association's Resolution of 11 May 1916 called for a series of reports on various sciences. The report on Geodesy, by F.W. Dyson, C.F. Close and E.H. Hills, resulted in the setting up of a Committee 'To discuss the present needs of Geodesy, including its relation to other branches of Geophysics, and to report ...'. The Chairman was C.F. Close, and the Secretary was E.H. Hills, whose folder this originally was.

On the appointment of a Committee in Cambridge to consider the establishment of a Professorship with a Geodetic Institute, the B.A. Committee's work came to an end (see letter, 30 June 1919).

The folder, which runs May 1916-July 1919, includes preliminary material, correspondence with colleagues, members of the committee, agendas, memoranda, committee arrangements, appointments, etc.

Also included is earlier correspondence, 1915, re the International Geodetic Association.

Cambridge

B.2 Correspondence exchanged between H.F. Newall and G.P. Lenox-Conyngham, re the funding, setting up and organisation of a school of Geodesy at Cambridge. The letters are ms., with typed transcripts.

Enclosed with the material is a letter, 1960, to 'My dear Ben' (B.C. Browne) from Lenox-Conyngham's daughter who had found the letters among her father's papers and thought them of historical interest. Browne died in 1968 and Bullard presumably inherited them.

The letters run 23 December 1918-April 1921. In his letter of 19 April 1919 Lenox-Conyngham writes 'The last two days have been rather anxious ones, with this attempted rebellion at Amritsar and elsewhere'.

Correspondence March-April 1921 explores the possibility of Lenox-Conyngham's appointment as Director of the proposed school.

B.3 2pp. ms. account by Bullard 'Fifty years of Geodesy and Geophysics at Cambridge', prepared for the 50th anniversary of the founding of the Department, 1971.

With brief correspondence re Praelectorship in Geodesy at Trinity College, Cambridge.

B.4 Annual Reports of the Committee for Geodesy and Geophysics, 1932-36, 1938, 1940-43, 1945-48.

These reports have been drawn upon for information on research at the Department, and particularly Bullard's own projects.

Cambridge

B.5-B.29 POSTWAR ORGANISATION AND RESEARCH, 1943-48

B.5 -B.10 Memoranda and Reports

B.11-B.22 Equipment

B.23-B.29 Research and administration

Bullard's earliest note on postwar requirements dates from 1943 (B.5-B.7). He was a member of the Royal Society Committee on postwar needs in Geophysics set up in February 1944, to which he submitted several memoranda, and whose recommendations included the extension of the Cambridge Department. See F.86-F.89.

Bullard was also a member of the joint committee appointed by the Royal Society and the University Grants Committee to organise the distribution of government surplus stores to universities at the end of the war. He was active in visiting various official stores and depots, drawing up lists of material, and - as representative of Cambridge University - bidding for material on behalf of other Cambridge departments as well as the Department of Geodesy and Geophysics (B.11-B.16).

On his return in 1945 to his post as Reader in Geophysics, Bullard was for practical purposes head of the Department and responsible for matters of equipment, staff and day-to-day administration (B.17-B.29).

B.5-B.10 Memoranda and reports

B.5 'The Post-War Development of Geophysics. Draft of a scheme to be submitted to the Nuffield Trustees.'

8pp. typescript draft, with a covering letter from Sir Ronald Fraser dated March 1943, bearing ms. corrections by Bullard and Fraser.

Cambridge

B.6 'Draft of a scheme for the Post-war development of Geophysics.'

9pp. typescript with ms. revisions. Uses similar material to B.5.

B.7 'Notes on the cost of providing for Geophysics in Cambridge.'

9pp. typescript and ms. draft by Bullard, written to supplement the above, July 1943.

B.8 'Report of the sub-committee appointed by the Committee for Geodesy and Geophysics.' (Cambridge).

Report, and amendments, prepared for meeting on 20 September 1943.

B.9 Letter from Bullard to Lenox-Conyngham, setting out his views on the development of geophysics at Cambridge, with reference to the above, March 1945.

B.10 'Draft report of the Committee of the General Board on the future of the Department of Geodesy and Geophysics', 1948.

See D.351 for a research proposal, 1949.

B.11-B.22 Equipment

B.11 Draft memoranda re distribution of surplus government equipment to universities, correspondence with officials, ministers, colleagues, etc., re compilation of lists of material available through scheme, March 1945-March 1946.

B.12 Official lists of Government surplus stores made available for purchase via University Grants Committee, various dates, 1945.

The list of radio components is annotated by Bullard and B.C. Browne.

Cambridge

B.13 Supplements to Ministry of Supply lists and miscellaneous other typescript lists or drafts for lists.

B.14 Correspondence, etc. re requirements of various Departments of Cambridge University (including Department of Geodesy and Geophysics), October 1945-August 1946.

B.15 Miscellaneous lists of requirements of machinery and equipment prepared by various Cambridge Departments (including Department of Geodesy and Geophysics).

B.16 Consignment notes, invoices, etc. for equipment supplied from various ministries and government stores to Department of Geodesy and Geophysics.

B.17-B.19 Correspondence and papers re gravimeter for research in the Department of Geodesy and Geophysics, 1946-47 (not indexed).

B.17 With officials and colleagues re Graf gravimeter from Germany through Treasury Reparations Scheme.

B.18 With commercial firms and suppliers of parts and equipment.

B.19 Bullard's ms. notes and diagrams.

B.20-B.22 Correspondence with industrial firms and suppliers re various items of equipment for Department and research projects. Not indexed.

B.20 1945

B.21 1946. Correspondence April includes letters explaining purpose of research project to make a Gravity Survey of the western seaboard of the British Isles, under the joint Navy/Royal Society advisory committee for shipborne research. Correspondence August is re standardisation of thermometers.

Cambridge

B.22 Miscellaneous receipts, invoices, consignment notes, etc. for departmental supplies, 1945, 1946.

B.23-B.29 Research and administration

B.23 Correspondence, 1944-46, with Lenox-Conyngham, B.C. Browne, L.R. Flavill re resumption of work at Cambridge, and with others coming or applying to work there.

B.24 Correspondence and papers re Shell Studentships in Geophysics, 1945.

Two Studentships were offered by the Royal Dutch Shell Group of Companies, to begin 1 October 1945; folder includes correspondence with the Company and with Cambridge University re setting-up of scheme, draft notice, etc. and with applicants for the first studentships.

B.25 Correspondence, 1946-47, re proposed collaborative research on echo-sounding at sea, with Admiralty and others, and its funding.

B.26 Correspondence re trials of Siebe Gorman Bathysphere at Portsmouth. Includes ms. report by B.C. Browne who attended as a witness, 1946-47.

B.27 Correspondence, 1945-46, re requests to visit Bullard or seek advice on starting or continuing research projects, set up institutes, etc.

B.28 Shorter administrative correspondence, 1946.

B.29 Correspondence with Cambridge University General Board and Treasurer re affairs of the Department: budget estimates, staff, building requirements. 1945-46.

Cambridge

B.30-B.73 RESEARCH AND ADMINISTRATION, 1956-80

B.30-B.37 Research proposals

B.38-B.64 Expedition and research reports

B.65-B.73 General administrative material

It should be noted that much of the material on research is by other members of the Department, principally M.N. Hill. The authorship is noted where known.

See Section D for further material on research projects undertaken at this period.

The 'General administrative material' at B.65-B.73 consists of the surviving documents from Bullard's own files and is in no sense a comprehensive record of the Department.

B.30-B.37 Research proposals

B.30 'Proposed survey of the mid-Atlantic ridge.'

2pp. draft, n.d., probably written for G.E.R. Deacon by M.N. Hill in 1958, shortly after D.H. Matthews joined the Department. (Information from D.H. Matthews, 1983.)

B.31 'Proposed future plans for marine investigations by the Department of Geodesy and Geophysics ...'

7pp. typescript by M.N. Hill, November 1959.

B.32 'Geological and Geophysical investigations of the floor of the ocean and of neighbouring shallow seas undertaken by the Department ...'

A historical survey, 6pp. typescript, by M.N. Hill, November 1959.

B.33 'Seismology in the United Kingdom. Future requirements.'

3pp. typescript, no author, January 1960.

Cambridge

B.34 'NATO Magnetic Survey.'

5pp. typescript + tables and notes (the latter signed 'DHM' [Matthews], 9 March 1962).

B.35 'Needs of the Department ... for the Quinquennium 1962-67', 4pp. typescript memorandum, no author or date.

B.36 'Data logging and data reduction at sea.'

4pp. typescript by D.H. Matthews, July 1965.

B.37 'Marine Geophysics at Cambridge.'

3pp. circular letter by D.H. Matthews, on past research and future proposals, January 1980.

B.38-B.64 Expedition and research reports

B.38 Untitled journal, 18 July-30 August, no author or year, but almost certainly by Hill and referring to R.R.S. 'Discovery II' expedition, 1956.

19pp. typescript. All references to work with the proton magnetometer are marked by Bullard. See D.484-D.506.

B.39 'M.N. Hill's journal of the cruise of "Discovery II" May to July 1958.'

28pp. typescript.

B.40 'The cruise of R.R.S. "Discovery II" May 9 to July 28, 1958. Report from the Department ....'

13pp. typescript, with contributions by several participants.

Cambridge

B.41 'MNH's journal of "Discovery II" cruise August-October 1960.'

22pp. typescript + 3pp. 'Extract from journal of A.S. Laughton', and 'Station List'.

B.42 'Expedition by R.V. "Sarsia", June 19-29 1961.'

3pp. typescript by Hill.

B.43 'MNH's journal of "Discovery II" expedition: January-March 1962.'

35pp. typescript.

B.44 'Station list' for above expedition.

4pp., and chart.

B.45 'Cruise Report' for above expedition.

5pp. typescript, no author.

B.46 Report on Indian Ocean Expedition in H.M.S. 'Owen', 12-26 April 1962.

3pp. typescript by B.C. Browne.

B.47 Report on expedition in R.V. 'Argo' (a Scripps Institution vessel), October-November 1962.

2pp. typescript by T.J.G. Francis.

B.48 'H.M.S. "Vidal" - operation NAVADO. Report on the work of members of the Department ... during the cruise from Portland to Hamburg and back', September-October 1963.

2pp. typescript by B.C. Browne.

Cambridge

B.49 'H.M.S. "Vidal" ... Portland to Oporto,' October 1963.

2pp. typescript by J.O. Beaumont.

B.50-B.64 Office of Naval Research Grants.

Application, budgets, reports, etc. prepared for O.N.R., many relating to the expeditions above. B.50 is a budget for 1960-61 in which the grant reference is NR 083-153; on the other reports the contract number is N 62558-2704.

The dates run 1 December 1960 to 28 February 1963; some of the reports are signed by M.N. Hill and other members of the Department.

B.65-B.73 General administrative material

B.65, B.66 Requests to visit/work in Department, letters of thanks.

B.65 1960-69

B.66 1970-77

B.67 Correspondence on research at Department, 1960-68.

B.68 Miscellaneous correspondence re staff, research, expeditions 1963-79.

Includes list of 'The Whereabouts of Cambridge Mariners', listing names and careers of research students, 1950-79.

B.69 Correspondence, 1968-69, with Hydrographer of the Navy re the transfer to his new Geophysical Laboratories of a sine lift from the Cambridge Department.

Cambridge

B.70 Correspondence, 1974, re the organisation of 'earth science' at Cambridge.

Bullard's reply of 24 October, in answer to a request for information, is an interesting summary of his work on the history of the subject at Cambridge, its likely development there, and his own suggestions for its place in university studies.

B.71 Correspondence with J.A. Jacobs (Bullard's successor as Professor) re research and affairs of the Department, 1975-79.

Correspondence 1979 includes discussion on the merging of 'Earth Sciences Departments' at Cambridge and the proposal to name the Madingley Rise site the 'Bullard Laboratories'.

B.72 Miscellaneous correspondence re buildings.

Includes press report from O.N.R. 'European Scientific News' re opening of new building at the Department, and a letter from Bullard to Jacobs, 1978, about the apple tree at Department, a scion of Newton's apple tree, obtained by Bullard from Kew in 1970.

B.73 Correspondence, 1969-70, with David Peace re engraved glass door for new building.

Cambridge

B.74-B.88 LECTURES

These are notes for University lecture courses, mainly at Cambridge, but see B.76-B.78 for lectures originally given at Toronto. Very few are dated.

Other lectures given in Cambridge may be found in Section G.

B.74 Miscellaneous lecture schedules and summaries, various dates and undated.

B.75 Extensive sequence of notes for courses of lectures in Mechanics, 28 numbered pages and many intercalated pages.

pp. 2 and 3 only of similar material.

B.76 '2nd Year Acoustics Lect.'

Miscellaneous ms. notes, some paginated. In original folder. First given at Toronto 1948.

B.77 'Applied Geophys. Lect.'

Miscellaneous ms. notes, some paginated. In original folder, n.d., similar to above.

B.78 'Lecture notes'

Miscellaneous ms. notes on various topics in physics. In original folder, n.d., similar to above.

B.79 Miscellaneous shorter lectures:

'Physics for Arts Students, 1956'

'Origin of the Earth's Magnetic Field', 1957

'Rockets and Satellites (to Arts Students 1959)'

Cambridge

B.80 'Earth's Magnetic Field'

Course of 8 lectures, 1958. In original folder.

B.81 'Geological Time'

Course of 3 lectures, Michaelmas Term 1959. In original folder.

B.82, B.83 Notes for courses on Geophysics, various dates, numberings and paginations (few complete).

B.82 1956, 1961, 1962. In original folder.

B.83 1967, 1971, 1973 (complete course of 8 lectures).

B.84 'Mechanics'

20pp. sequence, 1960. In original folder.

B.85 Similar sequence paginated 8-23.

B.86 'Earth structure and oceans'

7 lectures, October 1963.

B.87 'Phys. of Earth. Part 2 General'

Lectures 2-8 of course, October 1967. In original folder.

B.88 Miscellaneous shorter lectures:

'Minerals from the deep sea', 1971

'Earth's magnetic field', 1974

'Continental Drift', 8th lecture (only), n.d.

Cambridge

B.89-B.92 OTHER CAMBRIDGE DEPARTMENTS AND INSTITUTIONS

In alphabetical order.

B.89	Department of Botany	1964
	Cambridge Philosophical Society	1946, 1964
B.90	The Cavendish Laboratory	1956-63, 1969, 1973

General correspondence, principally with N.F. Mott but also with other colleagues, on research, funding, personnel, lectures, etc.

B.91	Computer Laboratory	1971
	Pye of Cambridge	1970
	Scientific Periodicals Library	1970, 1977
	University Chemical Laboratory	1973, 1974
B.92	University General Board	

2pp. 'Comments ... on the development of the University', with a ms. note at end 'prob. about 1957 or 1958'.

SECTION C CALIFORNIA C.1 - C.43

INTRODUCTION TO SECTION C

Bullard's first documented connection* with the University of California was during his period at Toronto, when he spent the summer of 1949 working with A.E. Maxwell at the Scripps Institution of Oceanography on marine heat flow (C.12-C.14). This work, mainly concerned with the design of apparatus, was the start of continuing work through the 1950s and its successful completion was regarded as a 'historic occasion' for Scripps (see C.26). A typescript draft report of the 1949 work, by Bullard and Maxwell, appears at G.25. See also A.249.

During the 1949 visit, Bullard was approached to consider appointment as Director of Scripps, but declined in view of his decision to return to Britain as Director of NPL (see C.14). His connection with Scripps, and the friends and colleagues there, remained among the most valued of his life. He returned regularly over the years in various research and teaching capacities, and became a United States resident, based in California, after his retirement in 1974. The offer of the Directorship of Scripps was repeated in 1964 (see C.18) and again declined, this time from loyalty to Cambridge.

The symposium organised in his honour at Scripps in January 1980 was a tribute to his role in animating research projects and to the affection he inspired. See A.119-A.121.

* See J.133 for correspondence with L.B. Slichter in 1947 offering Bullard a post at the newly-constituted Institute of Geophysics at UCLA where Slichter had been appointed Director.

SOME OF THE MATERIAL IN THIS SECTION MAY BE SUBJECT TO RESTRICTION.

California

A note on nomenclature

Bullard's long connection spanned various expansions, mergings and changes of organisation and title at the University of California, not all of which are consistently represented in the references or indeed on the letter-heads of the correspondence. The following outline of events, quoted by permission, was provided by the Archivist of the Scripps Institution of Oceanography Library:

> 'The Scripps Institution of Oceanography has been part of the University of California since 1912. It was founded in 1903 as the Marine Biological Association of San Diego, and its name was changed in 1912 to the Scripps Institution for Biological Research of the University of California. In 1925 the name was changed to Scripps Institution of Oceanography. From 1912 to 1937, the Berkeley campus of the University of California granted degrees to students studying at Scripps and undertook some administrative and fiscal responsibility concerning the operation of Scripps. In 1938 these functions were transferred to the new University of California, Los Angeles (UCLA). Since 1960, when the University of California, San Diego (UCSD) was founded, Scripps has been officially defined as a research and graduate school of UCSD.
>
> The Institute of Geophysics and Planetary Physics (IGPP) is a university-wide institute of the University of California. There are branches of IGPP at Scripps and at UCLA. The institute was founded in 1946 as the Institute of Geophysics, and its headquarters were at UCLA. From 1947 to 1960, Walter Munk was the sole representative of the institute on the Scripps campus. In 1960, the Scripps branch of the institute was established, and the name of the institute was changed to its current form. Although the La Jolla branch of IGPP is physically located on the Scripps campus and cooperates closely with Scripps, in administrative terms it is independent of any single University of California campus.
>
> The University of California, San Diego, began in the late 1950s as the brainchild of Roger Revelle, then director of the Scripps Institution. 1960 is generally recognized as the official date of its establishment even though some UCSD faculty was recruited before that date. Before the UCSD campus was completed, its Institute of Technology and Engineering and School of Science and Engineering were physically located on the Scripps Campus.
>
> The University of California, San Diego, was initially called the University of California, La Jolla. In fact, one dissertation was accepted by the University and a degree granted under that name. For political considerations, however, the name was changed in 1961 to University of California, San Diego. It is acceptable to refer to it as the San Diego campus of the University of California as well.'

California

C.1 - C.11 ADMINISTRATIVE AND PERSONAL

Includes Bullard's appointments, visa applications, resident status, retirement pension, insurance.
For other personal material see Section A passim.

C.12 - C.28 RESEARCH AND ACADEMIC

Includes research correspondence and papers, staff, promotions, expeditions, meetings, conferences, publications, other institutions of the University.
Much of this is necessarily exchanged during Bullard's periods at Cambridge away from California, and is thus only a partial record.
For work on BOMM, see D.528 - D.576.
For work on palaeomagnetism, see D.586 - D.592.
For work on nuclear waste, see D.613 - D.643.
For consultancies in California, see E.99 - E.113, E.185 - E.187.

C.29 - C.43 LECTURES AND TEACHING

California

C.1-C.11 ADMINISTRATIVE AND PERSONAL

C.1 1961 (one letter only).

1962 Includes correspondence, July, re Bullard's appointment as 'research associate in the Institute of Geophysics and Planetary Physics at the University of California, San Diego'.

1963 Includes correspondence, July, re Bullard's appointment as 'Visiting Professor V for a period of three months each year commencing September 1, 1963, in the Institute of Geophysics and Planetary Physics'.

C.2 1964-66 Includes correspondence, February 1966, re Bullard's appointment as 'Professor, Step V, in the Scripps Institution of Oceanography at the University of California, San Diego ... from July 1, 1966, for a period of three months per year'.

C.3 1967-68

C.4 1969-70 Includes a note, April 1970, by Bullard of his research at IGPP on Plate Tectonics and on the Earth's magnetic field, for inclusion in Institute Report. Also included is material about the proposed International Center of La Jolla.

C.5 1971-72 Includes correspondence, May 1971, about Bullard's promotion to what he terms in his letters of thanks, 'a yet grander kind of professor'.

C.6 1973-74 Includes correspondence re Green Scholarships (see also C.8, C.27) and to Bullard's visit to Berkeley (see also H.20).

C.7 Correspondence, visa applications and other miscellaneous papers re granting of U.S. resident visas to Bullard and to Lady (Ursula) Bullard, December 1974-August 1976.

Includes biographical information, details of previous appointments and salary at Scripps Institution.

California

C.8 1975-76 Includes correspondence, December 1975-January 1976, on Bullard's appointment as a 'Cecil H. and Ida Green Scholar', and correspondence, October 1976, on his appointment as 'Professor Recalled to Active Duty'.

C.9 1975-76 Correspondence, etc. re retirement pension. See A.11 for a letter by Bullard commenting on the University pension system.

C.10 1975-78 Correspondence, etc. re medical insurance and claims.

C.11 1977-79 Includes correspondence, December 1977, re Bullard's re-appointment for Fall Quarter 1977 and Winter Quarter 1978, his letters of resignation, April and May 1979, and a copy of a paper by R. Revelle 'The Adolescence of The Elephant' given at the 75th anniversary banquet of the Scripps Institution of Oceanography, April 1978.

Correspondence 1979 testifies to the great success of Bullard's lectures and teaching.

C.12-C.28 RESEARCH AND ACADEMIC

C.12-C.14 Correspondence and papers, 1948-49, re Bullard's visit to Scripps, June-September 1949, to work on marine heat flow.

See also A.249, C.26, G.25.

C.12 Invitation and arrangements, comments on the research proposal sent to C. Eckhart (Director, Scripps Institution).

C.13 Letters of thanks after visit, list of 'Submarine geologists ...' with comments by Bullard.

California

C.14 Letters re the offer to Bullard of the post of Director of Scripps. In his letter of 9 September 1949 to President Sproul, Bullard explains his reasons for declining, his admiration for Scripps and his warm commendation of R. Revelle for the Directorship.

C.15 1962 Includes correspondence, February-March, re W.H. Munk's fellowship at Churchill College, Cambridge, to 'extract components of oceanic and atmospheric tides from very long geophysical time series' (jointly with Bullard); correspondence on ocean heat flow with W.H.K. Lee and others.

C.16 1963 Includes continuing correspondence on heat flow, and preliminary suggestion for Bullard's part-time appointment (see also C.1).

C.17 1963-64 Correspondence re Scripps expedition in R.V. Baird to Easter Island, Juan Fernandez and Valparaiso in August 1964.

See D.586-D.592 for research on palaeomagnetism arising from expedition.

C.18 1964 General correspondence on scientific matters, including BOMM, SCOR (q.q.v.). Letter of 13 May asks Bullard to consider nomination as Director of Scripps.

C.19 1964-65 Correspondence with W.H.K. Lee re publication 'Terrestrial Heat flow' (ed. Lee), Geophys. Monogr. No.8, to which Bullard contributed a 'Historical introduction' (Bibliog. 1965e).

C.20 1965 Includes correspondence and data re magnetic reversals for rocks from South Pacific expedition (see D.586-D.592), correspondence re proposed publication in Bullard's honour of papers of International Symposium on Geothermal Problems at I.U.G.G. General Assembly, 1966, etc.

California

C.21 1966-67 General scientific correspondence re research and appointments.

C.22 1966-67 Correspondence and papers re Scripps NOVA expedition to southwestern Pacific. Bullard was on Horizon, 13 July-8 August, Suva-Brisbane, for sampling of palaeomagnetic rocks and volcanic lavas.

Includes a carbon letter from Bullard, 1970, re specimens collected on NOVA expedition.

C.23 1968 Correspondence with and re Y. Bottinga.

C.24 1968-70 Includes congratulations on the award of the Vetlesen prize, a note, August 1969, by Bullard on 'Magnetic Stratigraphy and JOIDES', Bullard's assessment of the work of IGPP, etc.

C.25 1971-73 General correspondence on research and appointments.

C.26 1973 Material on the history of research on marine heat flow at Scripps, stemming from Bullard's joint work in 1949 (see C.12-C.14). Includes a draft account of the subject by E.N. Shor, with comments and correspondence by Bullard, September-October 1973.

See A.4 for a copy of the article 'E.C. Bullard's First Heat-Probe' as published in 1984.

C.27 Correspondence and papers re selection of Green Scholars, funded by Cecil and Ida Green 'for the benefit of the Institute of Geophysics and Planetary Physics and ... the entire Earth Sciences community at Scripps Institution of Oceanography', 1973-74, 1979.

Bullard was Chairman of the selection committee and was himself a Green Scholar in 1976 (see C.8).

Folder includes background information on the terms of the gift.

C.28 1974-78

California

C.29-C.43 LECTURES AND TEACHING

Bullard was concerned with various sets of lectures for the APIS* courses. He gave lectures, and also set, graded and moderated tests and examinations. He explains in his letter of resignation (C.11) that he had previously been little involved with undergraduate teaching, but had found it enjoyable; this was clearly reciprocated (C.31). The several records of tests and examinations indicate his conscientious yet humane approach to this aspect of academic life, even in 1979-80 when he knew that he was terminally ill (see esp. C.33, C.34).

* APIS = Applied Physics and Information Sciences.

C.29 General correspondence and circulars on timetables, schedules, etc. 1967, 1974-79.

C.30 Reading-lists, orders for books/reprints, handouts and teaching material for Bullard's classes.

C.31 Evaluations of, and comments on, Bullard's courses by participants.

C.32 Tests and examinations: question papers, draft or 'ideal' answers, various dates, 1973-79.

C.33 Material re examinations, winter 1979 (Bullard's last at Scripps).

Arrangements, scalings, detailed performances.

C.34 Correspondence with and re students and their examination grades.

1974, but mainly 1978-80, when Bullard was seriously ill but still brought meticulous care to re-assessment, comments on work, etc.

C.35 Lists of participants in Bullard's courses, and their gradings, 1978, 1979.

California

C.36 21pp. ms. notes for course of lectures on 'The Earth', some dated 1973, 1974.

C.37 11pp. ms. notes for course of lectures on 'Earth's Magnetic Field (Scripps Oct. 1974)', and 2pp. additional notes.

C.38 Shorter ms. notes for lectures on 'Magnetic Limestones' and 'Atlantic continental edges', both October 1974.

C.39 Ms. notes, arrangements and schedules for lectures and seminars on Plate Tectonics, January 1976.

C.40 Ms. notes for lectures on 'Plate tectonics', 'Fits and Splits', 'Earth's magnetic field', 'Disc Dynamos', all October-December 1977.

C.41 Ms. notes, arrangements and schedules for lectures and seminars on 'Development of ideas on plate tectonics' and 'Origin of earth's magnetic field', 1978 and 1979.

C.42 Miscellaneous shorter notes for lectures on various topics, given at La Jolla, various dates, 1965-73.

C.43 Miscellaneous notes, summaries of lectures, etc., various dates or undated.

SECTION D RESEARCH D.1 - D.651

INTRODUCTION TO SECTION D

Almost all this work is in manuscript, and a substantial part of it remains in Bullard's original folders bearing his descriptions and dates, which are quoted in inverted commas in the catalogue entries. The policy of retaining the original arrangement of the folders has been followed even when only one or two sheets of paper were contained; D.143, D.293 contain folders now empty from which material had been removed or redistributed by Bullard in ways not now easily traceable. Very bulky folders, and a fortiori the large filing-drawer dividers Bullard sometimes used to hold his more extensive accumulations of material, have been split into more manageable units for ease of reference.

Much of the early work on gravity measurement and explosion seismology, conducted from the Cambridge Department of Geodesy and Geophysics, includes correspondence with or to the then Reader, Sir Gerald Lenox-Conyngham, and other members of the Department. In conjunction with Section B it thus forms a useful contribution to the history of the subject and the Department.

To a considerably less extent, some of the work on geomagnetism conducted when Bullard was Director of the National Physical Laboratory includes material relating to staff and activities there.

The topics are presented in chronological order of the earliest documented evidence of Bullard's involvement.

Research

LIST OF CONTENTS

Research

D.477-D.483	EARTH DENSITY	c.1951-56
D.484-D.506	PROTON MAGNETOMETER	1956-58, 1966
D.507-D.513	SEISMIC REFLECTION/APPLIED SEISMOLOGY	1956-58
D.514-D.517	ARGON DATING With an introductory note	1956-61
D.518-D.522	SECULAR VARIATION	c.1958-59
D.523-D.576	COMPUTER APPLICATIONS	
	EDSAC D.523-D.527 With an introductory note	c.1959-62
	BOMM D.528-D.576 With an introductory note	1960-76
D.577-D.585	CONTINENTAL DRIFT	c.1962-65, 1975
D.586-D.592a	PALAEOMAGNETISM	1964-66
D.593-D.609	ELECTRICAL CONDUCTIVITY OF OCEANS	1965-71
D.610-D.612	MAGNETIC VARIATIONS	1967-69
D.613-D.643	ENERGY SOURCES/NUCLEAR WASTE With an introductory note	1976-80
D.644-D.651	MISCELLANEOUS	

Research

D.1-D.17 SCHOOL AND UNIVERSITY NOTEBOOKS, 1925-29

D.1, D.2 School Notebooks

D.1 Black notebook, inscribed 'E.C. Bullard 28/12/25 Chemistry'.

D.2 Hardback notebook, inscribed 'E.C. Bullard Feb 4th 1926 Repton. Cohen's Organic Chemistry'.

D.3-D.17 Undergraduate notebooks

Chemistry

D.3 Hardback notebook, inscribed 'E.C. Bullard 14/10/26 Chemistry' (few pages used).

D.4 Hardback notebook, inscribed 'E.C. Bullard. 16/1/27. Volumetric'. Record of experiments.
January 1927-February 1928, some checked and counter-signed 'J.B.'.

D.5-D.7 Three jotter-type notebooks, all bearing Bullard's name and two with a later note '1927 or 1928'.

Mineralogy

D.8 Blue notebook, 'Practical Mineralogy', inscribed inside front cover 'E.C. Bullard. Clare. 18/1/27', with a ms. note 'These note books were returned to me by Mrs. Hutchinson after Prof. Hutchinson's death. E.C.B. 2/2/38'.

Research

Physics

D.9 Small red notebook, labelled 'Heat'.

D.10 Large springback folder. The inscription is 'E.C. Bullard, Repton, Oct. '25', but the contents are miscellaneous, some possibly dating from Repton, but most on various topics in physics and many bearing various dates 1926-29, in no obvious order.

D.11 Hardback notebook, labelled 'E.C. Bullard. 14/10/26. Physics'.

D.12 Black looseleaf notebook, of notes taken at lectures at Cambridge, 1926.

Includes: 'Mechanics & Properties of Matter. Mr. Woods'

'Organic Chemistry. Prof. Sir W. Pope. Mr. Palmer'

'Mineralogy. Prof. Hutchinson'

D.13 Springback folder, inscribed 'E.C. Bullard. Clare. 7/1/28. General Dynamics from notes taken at Mr. Pars' Lectures Michaelmas Term 1927'.

This is a written-up account, paginated 1-115, with an index of 57 sections.

D.14 Green notebook, inscribed 'E.C. Bullard. Clare. 14/10/27. Practical crystal physics'.

D.15 Red notebook, inscribed 'E.C. Bullard, Clare. 10/10/27. Practical Physics Dr. Ellis' Lab.'.

D.16 Red notebook, inscribed 'Part 2 Phys. Practical Class'. Work runs 15 October 1928-26 February 1929.

D.17 Softback notebook, labelled 'E.C. Bullard, Clare. 17/3/28. Translation of Schrödinger, 1926'. (Translation, presumably by Bullard, of papers on wave mechanics by E. Schrödinger.)

Research

D.18-D.23 ELECTRON SCATTERING, 1929-31

This was Bullard's first research, conducted at the Cavendish Laboratory under Rutherford, in collaboration with H.S.W. (later Sir Harrie) Massey.

See A.13 for an account by Bullard of the work and the conditions in which it was carried out in the 'attic' referred to in D.18. See also J.10, J.91.

D.18 Softbacked green notebook, inscribed 'E.C. Bullard, Clare. "The Attic". Long Vac. 1929'.

Experiments, mainly with apparatus, various dates July-August 1929.

D.19 Small hardbacked notebook, inscribed 'E.C. Bullard, Cavendish Lab. 11/10/29. Lab. Diary'.

Entries run 10 October 1929-15 February 1930.

D.20-D.23 Four notebooks on electron scattering. D.20 lacks the inside front page; D.21-D.23 are inscribed with the names of Bullard and Massey and are all titled 'Scattering of Electrons in Gases' and numbered 2, 3 and 4 respectively.

D.20 No name or title, experiments run 28 October 1929-13 June 1930.

D.21 Notebook 2, experiments run 13 June-3 August 1930.

D.22 Notebook 3, experiments run 7 August-12 November 1930.

D.23 Notebook 4, experiments run 14 November 1930-13 March 1931.

Research

D.24-D.294 GRAVITY MEASUREMENT

D.24-D.143 PENDULUM SWINGS/GRAVITY DETERMINATIONS, 1924-53

This was one of the principal activities of the Cambridge Department in its early days, 'largely because the Department possessed some pendulums' as Bullard characteristically put it later (A.7). Although he joined the staff only in 1931, the earliest records date from 1924 and were all kept in long-hand by Lenox-Conyngham and his assistants. They thus form an interesting contrast with the more sophisticated methods of automatic recording and more sensitive instrumentation to which Bullard himself contributed, using the talents of Leslie Flavill, the Departmental technician whom he valued highly. See, e.g. D.72, D.83, D.84.

The material is presented chronologically as far as possible; the 'African Gravity Campaign' for which Bullard was directly responsible has been treated as a separate entity at D.144-D.294. Although the early folders at D.24-D.33 contain work done by others before Bullard joined the Department, the folders themselves and the descriptions of contents are his. The sequence of folders is broken at D.34-D.38 to include Bullard's own laboratory and field notebooks, and resumes at D.39 with his folders of observations, correspondence and other research material.

Research

D.24 'Pendulum Observations, 1924-25'

Miscellaneous tables of observations, calculations, etc., mainly 20 May-1 June, and October 1925, all ms. in the hands of G.P. Lenox-Conyngham and G. Manley.

Included here is ms. 'Résumé of Work at the Pendulum House, Cambridge, November 1924-March 1925', 15pp., no author, and a letter to Lenox-Conyngham, February 1926, reporting 'gravity determinations made by our engineer Dr. F.A. Vening Meinesz'.

D.25 'Lawes (sic) Temp. & Press. Coeffts.'

Notes, calculations, bundles of observations, almost all by J.B. Laws, but with some notes by G.P. Lenox-Conyngham; related mainly to adjustments to pendulums and to thermal coefficients.

Includes report by Laws on 'Final adjustment of lengths of Danish Pendulums', September 1926.

Observations run various dates, June-September 1926.

D.26-D.28 Miscellaneous bundles of observations at Cambridge, Ordnance Survey Southampton and other stations, almost all made by J.B. Laws but with some additions and corrections by Lenox-Conyngham, August-September 1926.

Similar to above, but received as loose bundles. Now in three folders.

D.29 'Laws obns. 1926'

Includes 'Report on the Relative Determinations of Gravity during August and September 1926' by Laws, with maps and notes by Lenox-Conyngham, and 'Recalculation of Lawes' (sic) Results ...' by Bullard, n.d.

Research

D.30 'Col. Crasters Obns. 1926'

Folder containing 'Report on Adjustment of period of Oscillation of Pendulums Oct. to Dec. 1926', by Craster.

D.31 'Pesonen 1926-29'

Notes, calculations, chart of observations 1926-29 for brass and invar pendulums, in Bullard's hand (presumably a copy of earlier data).

D.32 'Jolly and McCaw 1927'

Folder referring to work by G.T. McCaw, Geographical Section, War Office, and H.L.P. Jolly, Ordnance Survey.

Includes report 'Gravity Determinations in 1927', 5 pp. draft with ms. corrections by Jolly and Lenox-Conyngham, report on 'Gravity Observations 1927', 14pp. by Jolly and McCaw, miscellaneous tables and notes by Jolly, 1p. 'Summary of 1927 Obsns.' by Bullard.

D.33 'Willis & Jolly 1930'

Referring to collaborative work on gravity determination with H.L.P. Jolly (Ordnance Survey) and J.C.T. Willis (Geographical Section, War Office).

Includes draft report, notes on loan of Cambridge Pendulum, maps, tables, etc., some by Lenox-Conyngham, and correspondence, April 1930-March 1931, between Lenox-Conyngham, collaborators and other colleagues re project.

D.34-D.38 Five notebooks of observations and calculations, of Cambridge and other stations, all inscribed with Bullard's name and address and numbered 1-5 as follows:

D.34 Notebook No.1, 6 July 1931-12 February 1932

D.35 Notebook No.2, 17 March - 8 August 1932

Research

D.36	Book 3	8 August - 13 December 1932
D.37	Book No.4	24 January 1933-12 July 1935
D.38	Book No.5	16 July 1935-11 August 1937

These books are occasionally referred to in the notes and correspondence.

D.39 'Pendulum Observations 1931'

Tables, graphs, calculations, etc. almost all by H.L.P. Jolly 1931 (with a few notes 1932), J.C.T. Willis and Bullard, at various stations.

Includes correspondence, 1931, all addressed to Lenox-Conyngham, from Willis and Bullard, re progress of research. Correspondence for September refers to damage sustained by pendulums, referred to in Annual Report for 1932 included in B.4.

D.40 'Pendulum Observations 1932'

Tables, graphs, calculations by Jolly and Bullard, almost all 1932 but a few 1931.

Includes letter to Lenox-Conyngham from Director General, Ordnance Survey and a copy of his annual report describing the history and progress of the collaborative research on gravity pendulum apparatus.

D.41 'E.C.B. Report 1931-32'

'Report on pendulum observations September 1931 to February 1932 by E.C. Bullard'

18pp. draft + 6 tables (2 copies).

Ms. drawings and figures.

Research

D.42 'E.C.B. Press. & Temp. Coeffs. 1931-32'

Folder of ms. tables and calculations.

D.43 'Royston etc. 1932'

Ms. records and calculations, all by Bullard, taken at Pendulum House and various sites in Cambridge district, various dates, October-November 1932.

D.44 'Magnetic & cooling measurements. E.C.B. 1932-33'

Miscellaneous ms. graphs, charts, calculations.

D.45 'Willis'

Folder of miscellaneous shorter correspondence between Bullard and Willis, re pendulum swings, 1931, 1933. Bullard's letter 5 October 1933 (written during his voyage to Africa) describes his discovery of rust in the invar pendulums. See Annual Report 1933-34 in B.4.

Included here is an unsigned letter to 'Dr. Wood', May 1941, about development of research methods.

D.46 'Jolly'

General correspondence about gravity determination research, with H.L.P. Jolly, 1932-36, and with M. Hotine, 1935-36 (both of Ordnance Survey).

Includes (incomplete) ms. historical note by Jolly on 'Gravity in the British Isles'.

D.47 'Kater's results'

Ms. calculations, and Bullard's copy of a letter to Jolly on subject, July 1933. Referred to in D.46 but kept in separate folder by Bullard.

Research

D.48 'Temp. coeffts. Jan. 1933'

Tables, charts, calculations, all by Bullard. Some pages annotated 'Record measured upside down'.

There is a note on the folder 'see also notebook 4' (D.37).

D.49 'Temp. & press. coeffts. of quartz pendulum 1933'

Tables, graphs, calculations, mainly comparing quartz and invar pendulums.

D.50 'Aneroids'

Certificates of comparison for various instruments, annotated by Bullard, 1933-36.

D.51 'Red Sea'

Tables and notes of 'Comparison of various observers in Red Sea', by Bullard, n.d. but kept in the sequence.

D.52 'Pendulum Observations 1933'

Bulky folder of tables, charts, calculations, etc., almost all by Bullard but some by Jolly.

Includes some material 1932 and 1934 as well as 1933.

Includes extensive observations at various stations in N. Wales by Bullard, March-April, and a 'check' for July-August swings dated 'Bay of Biscay October 1933' (when Bullard was en route to Africa).

D.53 '8-hr. swings Mar.-Aug. 1933'

Data sheets for Pendulum House, April and June only.

D.54 8-hour swings Southampton, June 1933

Observations, calculations (not all by Bullard).

Research

D.55 8-hour swings, various dates and stations, June-August 1933.

Observations, calculations (not all by Bullard).

D.56 8-hour swings, Southampton, July 1933.

Observations, calculations (not all by Bullard).

D.57 '8-hr. swings Oct. 1933'

Observations, calculations for Pendulum House, Cambridge.

D.58 'Cambridge 1'

Observations, calculations, October 1933, at Pendulum House, mainly comparison of quartz and invar pendulums. All by Bullard.

D.59 '8-hr. swings Nov.-Dec. 1933'

Observations, calculations, at Pendulum House (not all by Bullard).

D.60 '8 hr. swings Jan.-Feb. 1934'

Observations, calculations at Pendulum House. Not all by Bullard, but annotated and corrected by him.

D.61 '8 hr. swings Mar-Apr. 1934'

Similar material.

D.62 '8 hr swings May-June 1934'

Similar material.

D.63 '8 hr. swings June-July 1934'

Similar material (includes 1p. observations for August).

Research

D.64 'Hunstanton'

Observations, calculations, June 1934.

D.65 'Cambridge 2'

Similar material, and tabulated results. Mainly May-June 1934.

D.66 '8 hr swings July 1934'

Observations, calculations at Pendulum House. Not all by Bullard. Some by D.F. Munsey.

D.67 'Cambridge Oct. 1934'

Similar material, almost all by Bullard.

D.68 '8 hr swings Oct.-Dec. 1934'

Similar material, almost all by Bullard.

D.69 'Temp. coeffts. & summary 1934'

Calculations, tabulated summary of temperature coefficient data, 1926-34.

D.70 'Tables'

Folder of calculations, notes, tabulations, all by Bullard, mainly re temperature and density corrections of quartz and invar pendulums, n.d., kept with above. Some perhaps relating to later work with B.C. Browne, D.86-D.88.

Includes note of 'pendulum taken to Africa' and 'List of apparatus required at field station'.

D.71 Correspondence, 1934, with National Physical Laboratory re possible collaboration in gravity project.

Research

D.72 'Design of Quartz Pend.'

Folder of notes, drafts and drawings of various dates.

Includes: Note of 'Proposed alterations to quartz pendulums' July 1934, with additional notes by Lenox-Conyngham.

3 bundles of draft 'Design of Quartz Pendulum' paginated 1-12, 13-16, 17-22.

2 unpaginated bundles of calculations.

Note on 'South African Pendulum', August 1935.

Blueprints for 'Quartz Pendulum', by L.H. Flavill.

D.73 'Quartz Balance'

Miscellaneous calculations, n.d., but kept with above as separate folder.

D.74 Correspondence, 1935, re proposed 'magnetic survey of the oceans' and equipment for gravity measurements, with G. Norgaard. See also D.89.

D.75 'Cambridge Aug. 1935'

Observations, calculations, all by Bullard or checked by him.

D.76 'Southampton Aug. 1935'

Similar material.

D.77 'WESTON COLVILLE'

Similar material, September 1935.

D.78 'Cambridge Sept. 1935'

Similar material, all by Bullard.

Research

D.79 '8 hr swings 1935'

Observations, calculations, tables, all by Bullard, various dates, August-December 1935.

D.80 'Lincolnshire'

Observations, calculations, not all by Bullard, July, September 1936.

Note: Folders labelled 'Cambridge Sept. 1935', 'Cambridge July 1936 (Base Southampton)' and 'Cambridge July 1936 Base Downing Place', found empty in the sequence, are included at D.143.

D.81 '8 hr Swings 1936'

Observations, calculations, mainly for Southampton and Cambridge, various dates 1936. Includes 1p. 'Summary of 8hr swings made at Cambridge Oct. 1934'.

D.82, D.83 'O.S. Summaries'

Contents of bulky folder so described.

D.82 Correspondence and reports re 6th General Assembly, International Union of Geodesy and Geophysics, Edinburgh 1936.

Includes correspondence with H.L.P. Jolly re meeting and Bullard's contributions, maps, tables and reports on gravity anomalies prepared by Bullard. (In original folder.)

D.83 Earlier reports on gravity measurements, kept by Bullard with above and perhaps assembled by him for 1936 report. Several refer favourably to his improved methods of measurement and recommend their wider use.

Includes: N.P.L. Report 1927

Summary of gravity determinations 1928

Ordnance Survey Geodetic Work 1927-30 (incomplete)

Continued

Research

D.83 (Cont'd.) Ordnance Survey Pendulum Work 1927-33

List of Gravity Stations in Britain, by Jolly, n.d.

Report on Gravity by J.C.T. Willis, c.1933-34

Present Position of Gravity Survey of Africa, October 1935

D.84 'Thermal Syndicate' (Firm of quartz manufacturers.)

Correspondence with the firm re design and supply of quartz pendulums and other apparatus; includes various sketches for equipment by Bullard. Various dates, 1932-38.

D.85 'Metro-Vic' (Metropolitan-Vickers Electrical Co. Ltd.)

Correspondence with the firm re apparatus. One letter 1933, but mainly 1936.

D.86-D.88 Three folders of observations, calculations, notes, drafts, etc., mainly on the comparison and standardisation of pendulums. Much of the work is in the hand of B.C. Browne, who joined the Department as Demonstrator in Geodesy in Michaelmas Term 1936, replacing Bullard on the latter's election to the Smithson Research Fellowship of the Royal Society. See A.53.

B.86 'A_7, B_7 and C_7'

Observations, calculations, notes and drafts, on standardisation and correction of pendulums, various dates, 1937.

D.87 'A_7, B_7 and C_7 Pressure Coeffs.'

Similar material, various dates, 1937.

D.88 'A_7, B_7 and C_7 Temp. Coeffs.'

Similar material, various dates, 1937.

Research

D.89 'Norgaard'

'Static Gravity-meter', by G. Norgaard. 7 pp. report, n.d., c.1935-36

Miscellaneous observations, 1936, letter to Lenox-Conyngham re Browne's work on pendulums, 1937.

D.90, D.91 'Standardisation of Quartz Pendulums'

Contents of bulky folder so labelled (in the hand of B.C. Browne).

This refers mainly to a quartz pendulum apparatus made for the University of Cape Town; the pendulums were standardised by B.C. Browne at the National Gravity Station at Greenwich. See the Annual Report for 1938 in B.4.

D.90 Observations, calculations, notes of operating procedure, etc., various dates, November 1936-August 1937 (in the hands of Browne and Bullard).

D.91 Material relating to despatch of apparatus to Cape Town.

Includes ms. and typescript versions of descriptions of apparatus and instructions for its use (by Browne, heavily revised by Bullard), with letter and summary of standardisation procedure, December 1937.

Also included are ms. lists of apparatus, and valuation for shipping.

D.92 List of apparatus taken to South Australia by C. Kerr-Grant in order to make gravity determinations.

With ms. note by Bullard at head, and signed at end by Kerr-Grant, 10 June 1937.

See Annual Report 1938 in B.4.

Research

D.93 '8 hr Swings 1937'

Observations, calculations, summary, all by Bullard, various dates 1937.

Note: A folder also labelled '8 hr. Swings 1937', found empty in the sequence, is included at D.143.

D.94 '8 hour Swings at Downing Place Dec.-Jan. 1938-39'

Folder (not by Bullard, some by Browne) of observations, calculations, summary of work on pendulum standardisation by Browne dated October 1939.

Includes letter, 1949, from Browne to C. Kerr-Grant re his pendulum observations in Australia in 1938. See D.92, J.70.

D.95 '8 hour Swings. Pendulum House. Dec,-Jan. 1938-39'

Similar material, mainly by Browne, on standardisation of pendulums for Dehra Dun, India.

D.96 '8 hour Swings. Pendulum House. July 1939'

Similar material.

D.97 'Gravity Summary 1936-39'

Notes, tables, measurements for submission to 'Gravity on land' section of 7th General Assembly, International Union Geodesy and Geophysics, Washington, September 1939.

Research

D.98 Correspondence and papers, 1939, with National Physical Laboratory, re Bullard's visit to Washington Conference in September, and standardisation of pendulums at Department of Geodesy, National Physical Laboratory and National Bureau of Standards, and other matters on gravity determinations.

Includes miscellaneous comparative data by Bullard on pendulums at NPL and NBS, various dates, July-October 1939.

Also included is one letter from NPL, 1938.

D.99-D.103 Work on testing and standardising of apparatus and set of pendulums for University of Buenos Aires. The work was done in 1942 (D.99) much of it by Lenox-Conyngham himself with Bullard guiding the procedure and working out the results. The pendulums were re-swung in 1945 (D.100) and further testing took place in Cambridge in 1947 (D.101). Correspondence, etc. continues to 1949.

The pendulums are referred to in the data as 8A / B / C to denote the eighth set made by the Cambridge Instrument Company.

D.99 '8 hr Swings 8 A B C June-Aug. 1942'

Extensive folder of observations, calculations, etc., almost all by Bullard or Lenox-Coynyngham. Includes Bullard's ms. instructions for conducting the observations, and a letter from Lenox-Conyngham on his difficulties with them.

D.100 'Aug.-Sept.1945 8 A B C. Argentine Pendulums'

Extensive folder of similar material; calculations all by Bullard.

D.101 '1 A,B,C & 8 A,B,C in Argentine' 1947

Extensive folder of similar material, April-May 1947.

D.102 Correspondence re pendulums and variations of gravity at Cambridge and Buenos Aires, 1948, 1949.

Research

D.103 'Normal Continuous Argentine Pendulums 1949'

Observations, calculations, not by Bullard, various dates, June-July 1949.

D.104 'Cambridge (opening swings for New Zealand work)'

This refers to the standardisation of a set of pendulums sent to D.S.I.R., New Zealand, for a gravity survey, and a quartz clock which was also sent.

Observations, calculations, mostly by Bullard, some by R.I.B. Cooper, various dates, April-May 1947, with ms. note 'sent to N.Z. 11/2/48'.

D.105-D.107 'Theoretical Gravity Problems'

Contents of a bulky folder so inscribed (by R.I.B. Cooper) relating to research and joint paper with Bullard 'Determination of the masses necessary to produce a given gravitational field' Proc. R. Soc., A, 194 (Bibliog. 1948c).

D.105 Typescript and ms. draft for paper, heavily revised by Bullard.

D.106 Correspondence and research notes, 1947-48, from collaborator, and from G. Kreisel who had originally been a joint author but whose work was published as a separate paper (1947).

D.107 Extensive notes, graphs, calculations, all by Bullard. In original folder.

D.108 'South Africa 1948'

Observations, calculations, etc. standardising pendulum swings at Cambridge and Witwatersrand. All by R.I.B. Cooper.

Includes letter re gravity survey in South Africa, 1948.

Research

D.109 'Gravity Survey of the British Isles'

6pp. duplicated typescript note by Bullard 'prepared for consideration by the Sub-Committee on English gravity recently appointed by the National Committee for Geodesy'.

n.d. but probably March 1948. Recommends fuller coverage for Ireland and Scotland; see D.110-D.127 for the implementation of the research.

Correspondence (only) re paper by Cook and Thirlaway on 'Recent observations of Gravity in Wales and the Borders', 1948.

D.110-D.127 Observations and calculations for gravity survey of Britain, for various stations in Ireland, Scotland and England, standardised at Pendulum House, Cambridge.

The work was done in 1949, when Bullard was at Toronto; the material is therefore not in his hand, but forms part of the gravity survey project and of the work of the Cambridge Department.

Ireland

D.110	Dublin pendulums	March-April 1949
D.111	Sligo pendulums	March 1949
D.112	Cork pendulums	April 1949
D.113	Galway pendulums	March 1949
D.114	Post-Eire (standardising at Cambridge)	April 1949
D.115	Eire 1949 ('pre-Eirean swings' at Cambridge)	March 1949
D.116	Ireland 1949. Tabulated results for various stations, standardised with Cambridge. Includes letter, May 1949.	

Research

England

D.117	York	July 1949
D.118	Newcastle	July 1949
D.119	Cambridge (base swings before York and Newcastle)	July 1949
D.120	Cambridge (base swings after York, Newcastle and Edinburgh)	August 1949

Scotland

D.121	Edinburgh	July 1949
D.122	Edinburgh	September 1949
D.123	Aberdeen	September 1949
D.124	Cambridge (base swings)	September 1949
D.125	Cambridge (base swings)	October 1949
D.126	Edinburgh and Aberdeen. Various tables of results and drafts for paper.	

Australia

D.127	Folder of base swings standardised at Cambridge for similar work on Australian Survey	November 1949

Research

D.128-D.141	Continuing work on Gravity Survey, 1951
	Envelopes and folders of observations and calculations made at Pendulum House, Cambridge, and for other base stations as specified.
D.128-D.132	Five envelopes, National Physical Laboratory as follows:
D.128	24, 25 June
D.129	2, 3, 5 July
D.130	18, 19, 20 July
D.131	7, 8, 9 August
D.132	10, 11 September
D.133	Southampton Ordnance Survey, 28, 29 June
D.134	Bureau International de Poids et Mesures, Sèvres, 12, 13 July
D.135	Physikalisch-Technische Bundesanstalt, Brunschweig, 25, 26 July
D.136	Bad Harzburg, 29, 30 July
D.137	Cambridge Pendulum House, June
D.138	Cambridge Pendulum House, August
D.139	Cambridge Pendulum House, 5-7 September
D.140	Cambridge Pendulum House, 17-24 September
D.141	Cambridge Pendulum House, 24 October-2 November

Research

D.142 Brief correspondence and chart of gravity data for S.W. Asiatic Russia, 1953.

D.143 Empty folders originally containing pendulum data, various dates, 1935-37.

Research

D.144-D.294 AFRICAN GRAVITY CAMPAIGN, 1933-36, 1956

This research, though related to the general work on gravity determinations conducted at the Department, was Bullard's first major expedition and its published results (Bibliog. 1935, and especially the long paper in Proc. Roy. Soc. Bibliog. 1936a) aroused widespread interest. Characteristically, Bullard himself later referred to the work as 'what now seems a wholly erroneous interpretation of the origin of the rift valleys'.

The expedition was funded from various sources, including Cambridge University, the Royal Society and the Royal Geographical Society; Bullard also held a research fellowship from the Leverhulme Trust. He left Britain on 21 October 1933 and returned on 16 May 1934, having visited 57 stations, some more than once, situated in the then territories of Kenya, Uganda, Sudan, Belgian Congo and Tanganyika. An additional observation (no.58 in the sequence, now at D.224) was made in Cape Town on the journey home. Bullard was accompanied on the trip by his wife Margaret (Tom) who helped with some of the observations and record-keeping.

In addition to the gravity measurements which were the main research purpose of the 1933-34 expedition, Bullard also carried out observations at 14 stations on the secular variation of terrestrial magnetism. See especially the correspondence with the Carnegie Institution of Washington on the loan of equipment and the organisation of the work (D.146) and Bullard's journals, notes and observations (D.275 et seq.) See also letter from S. Chapman in D.151.

Before leaving Africa, Bullard discussed the possibility of continuing work on gravity determinations, to be undertaken by officers of the Survey Department of Tanganyika. The designated officer, W. Horsfield, visited Cambridge in 1934 to study the measurement technique and, using the Cambridge field-apparatus, carried out observations at 36 stations during 1935-36. A collaborative paper 'Gravity Measurements in Tanganyika Territory' appeared in 1937 (Bibliog. 1937a). Many of the observations and data-sheets at D.225-D.270 are signed or initialled by Horsfield

Research

or his assistant, R.N. Lissett, though all the reductions for topography and compensation were done in Cambridge by Bullard.

D.294 is later (1956) correspondence on gravity measurements in East Africa.

The material is presented as follows:

D.144-D.157	Organisation and funding of expedition, 1933-34
D.158-D.224	East African Station records (1-58), 1933-34
D.225-D.270	Tanganyikan Station records (1-36), 1935-36
D.271-D.293	Journals, calculations, writings
D.294	Correspondence, 1956

Research

D.144-D.157 Organisation and funding, 1933-35

D.144 'Leverhulme'

Application for Research Fellowship, and correspondence arising, 1933, and one letter 1935.

D.145 Application to Royal Society for grant for expedition; submitted by Lenox-Conyngham but drafted by Bullard.

D.146 Correspondence with Department of Terrestrial Magnetism, Carnegie Institution of Washington, 1933-34, 1937-38.

Correspondence 1933-34 deals with the loan to Bullard of a 'field-outfit' to enable him to conduct magnetic measurements in addition to the gravity observations. It includes detailed recommendations from the Institution for research on secular variations, operational instructions, etc.

Correspondence 1937-38 deals with Bullard's report, return of the 'cahiers' (see also D.276-D.281) and also refers to his seismic work at sea with R.M. Field (see also D.342-D.351).

Includes a copy of the Carnegie Institution's 'General Directions for magnetic observations ...', 1924.

D.147 'Kohlschütter'

Correspondence 1933-34 with Kohlschütter, who had made a similar expedition in 1899, about sites, loan of maps, etc. Correspondence 1934 refers to Kohlschütter's visit to Britain and meeting with Bullard and Lenox-Conyngham.

Bullard visited several of Kohlschütter's sites and repeated his observations. The similarity of the results was considered very satisfactory and was commented upon in the published papers (see D.291).

See also D.157, D.289.

Research

D.148 Correspondence with colleagues re equipment and information for observations in Africa, 1933-34.

D.149 Correspondence with suppliers of scientific instruments.

Cooke, Troughton & Simms, re pendulums, 1933-34.

Cambridge Instrument Company, re coil magnetometer, 1933-34.

D.150 Correspondence with Government officials in Africa re arrangements, transport, laisser-passer, 1933-34.

D.151 Correspondence with colleagues re research plans, information on local conditions, etc., 1933.

Includes letter from S. Chapman to Lenox-Conyngham on Bullard's proposed work on magnetic variation.

D.152 Correspondence, 1934, re additional gravity observation made at Cape Town on return journey (see D.224).

D.153 Miscellaneous notes by Bullard.

Includes 'Notes on matters connected with the E. African Expedition. Oct. 1933'; 'Notes on Quartz Pendulums' c.1934; 'Summary of rock densities' (for magnetism work); ms. notes of various gravity sites.

D.154, D.155 Correspondence with Lenox-Conyngham.

An extensive sequence of letters and cables exchanged every few days during trip, with scientific and a little personal news.

D.154 21 September-29 December 1933 (in original folder).

D.155 4 January-2 April 1934.

See D.274 for Lenox-Conyngham's laboratory notebook for the expedition.

Research

D.156 Correspondence re maps and plans of sites of observations in Africa, 1934.

D.157 Correspondence arising from visit.

Letter from H. G. Lyons congratulating Bullard and his wife on 'a really great performance' in obtaining data, 1934.

Letters from B. Willis about his own work in E. Africa and on Kohischütter's results, 1935.

D.158-D.224 East African Station Records (1-58)

This sequence of folders retains Bullard's original order. Each contains, unless otherwise stated, photographic observations, dated and timed and with ms. annotations; ms. records of pendulum used; standardisation with Cambridge base, etc. The records are in the hands of Bullard and Margaret Bullard, usually checking each other's work. Some have additional information describing the observation site, conditions of work or other relevant circumstances.

Additional notes, calculations, maps, etc. relating to this work are at D. 271 et seq.

D.158	'Mombasa No.1'	18-19 November 1933
D.159	'Mombasa No.1 Second visit'	17-19 March 1934
D.160	'Nairobi I. No.2'	23-25 November 1933
D.161	'Nairobi II. No.2'	19-21 December 1933
D.162	'Nairobi No.2' 3rd visit	1-4 March 1934
D.163	'Limuru No.3'	27 November 1933

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D.164	'Kijabe No.4'	28 November 1933
D.165	'Naivasha No.5'	29 November-2 December 1933
D.166	'Naivasha No.5' (2nd visit)	28 February 1934
D.167	'Gilgil No.6'	4-5 December 1933
D.168	'Nakaru No.7'	5-6 December 1933
D.169	'Nakaru No.7 (2nd visit)'	27-28 February 1934
D.170	'Eldama Ravine No.8'	7 December 1933
D.171	'Marigat No.9'	8 December 1933
D.172	'Kampi-Ya-Moto No.10'	9 December 1933
D.173	'Thomson's Falls No.11'	11 December 1933
D.174	'Nanyuki No.12'	13-16 December 1933
D.175	'Nyeri No.13'	16 December 1933
D.176	'Fort Hall No.14'	18 December 1933
D.177	'Equator No.15'	23-24 December 1933
D.178	'Equator No.15 (2nd visit)'	26 February 1934
D.179	'Kisumu No.16'	27-28 December 1933

Research

D.180	'Kisumu No.16 (2nd visit)'	23 February 1934
D.181	'Eldoret No.17'	1-2 January 1934
D.182	'Tororo No.18'	3-5 January 1934
D.183	'Jinja No.19 First Visit'	6 January 1934
D.184	'Jinja (Second Visit)'	11-14 January 1934
D.185	'Jinja No.19 Third Visit'	20-21 February 1934
D.186	'Kampala No.20'	7-9 January 1934
D.187	'Mbale No.21'	15-16 January 1934
D.188	'Soroti No.22'	17 January 1934
	Includes a later note by Bullard on corrected measurements used for this station in published paper.	
D.189	'Lira No.23'	18-19 January 1934
D.190	'Kitgum No.24'	19 January 1934
D.191	'Torit No.25'	20 January 1934
D.192	'Juba No.26'	22-23 January 1934
D.193	'Aba No.27'	24-25 January 1934
D.194	'Bai Nzoro No.28'	25-26 January 1934

Research

D.195	'Maie No.29'	26-27 January 1934
	With extensive comparative calculations by Bullard.	
D.196	'Nioka No.30'	27-28 January 1934
D.197	'Bogoro No.31'	29-31 January 1934
D.198	'Kasenyi No.32'	30-31 January 1934
D.199	'Irumu No.33'	31 January-1 February 1934
D.200	'Butembo No.34'	1-2 February 1934
D.201	'Kisolo No.35'	7-8 February 1934
D.202	'Kabale No.36'	8 February 1934
D.203	'Lwashamaire No.37'	9-10 February 1934
D.204	'Kichwamba No.38'	10-11 February 1934
D.205	'Kikorongo No.39'	12-13 February 1934
D.206	'Fort Portal No.40'	13-14 February 1934
D.207	'Kabwoya No.41'	15 February 1934
D.208	'Butiaba No.42'	16 February 1934
D.209	'Hoima No.43'	17 February 1934

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D.210	'Mumias No.44'	22-23 February 1934
D.211	'Kitale No.45'	24 February 1934
D.212	'Magadi No.46'	5-6 March 1934
D.213	'Kajiado No.47'	6-7 March 1934
D.214	'Ngorongoro No.48'	8 March 1934
D.215	'Arusha No.49'	9-10 March 1934
D.216	'Moshi No.50'	10-11 March 1934 15-16 March 1934
D.217	'Voi No.51'	16 March 1934
D.218	'Kilifi No.52'	20-21 March 1934
D.219	'Malindi No.53'	21 March 1934
D.220	'Kwale No.54'	23 March 1934
D.221	'Tanga No.55'	24-25 March 1934
D.222	'Pangani No.56'	26 March 1934
D.223	'Dar-es-Salaam No.57'	3 April 1934
D.224	'Cape Town No.58'	22 April 1934

This was the additional observation taken during the return journey. See correspondence arranging visit at D.152.

Research

D.225-D.270 Tanganyikan Station Records (1-36)

This sequence also preserves Bullard's original folders and arrangement. The material is similar, though the base stations vary and include Rugby, Southampton and Bordeaux. The field data are usually signed W. Horsfield or R.N. Lissett, but all the folders include checking, corrections and additional calculations by Bullard.

The stations are not numbered as in the 1933-34 sequence: they are in chronological order of date of observation.

D.269, D.270 are additional material relating to the work, also by Horsfield and Lissett.

D.225	'Singida'	24 January 1935
D.226	'Mgori'	25 January 1935
D.227	'Sela'	24 February 1935
D.228	'Chokaa'	4 March 1935
D.229	'Mbuyuni'	6 March 1935
D.230	'Myamya'	8 March 1935
D.231	'Dodoma Base'	11 March 1935
D.232	'Dodoma'	12 March 1935
D.233	'Chibwangula'	13 March 1935
D.234	'Kilosa'	15 March 1935
D.235	'Ruvu'	18 March 1935

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D.236	'Dar-es-Salaam 1st Visit'	20-21 March 1935 25 March 1935
D.237	'Dar-es-Salaam 2nd Visit'	24-26 June 1935
D.238	'Bahi'	27 March 1935
D.239	'Itigi'	29 March 1935
D.240	'Tura'	1 April 1935
D.241	'Goweko'	5 April 1935
D.242	'Kaliwa'	8-9 April 1935
D.243	'Uvinza'	12 April 1935
D.244	'Kazuramimba'	17 April 1935
D.245	'Kingwempimpi'	30 April 1935 2 May 1935
D.246	'Ruaha Bridge'	3-4 May 1935
D.247	'Iringa'	6-7 May 1935
D.248	'Nyamapara' Includes a note by Bullard on discrepant figure in published paper.	8-9 May 1935
D.249	'Trig. Pt. 182'	11 May 1935
D.250	'Itewe'	14 May 1935

Research

D.251	'Iwungu'	16-17 May 1935
D.252	'Kipembawe'	20 May 1935
D.253	'Mbogo'	21 May 1935
D.254	'Kitunda'	22 May 1935
D.255	'Shinyanga'	25-27 May 1935
D.256	'Mwanza'	28-29 May 1935
D.257	'Mafia'	13 June 1935
D.258	'Kilwa Kiswani'	15 June 1935
D.259	'Mikindani'	17 June 1935
D.260	'Lindi'	18 June 1935
D.261	'Kilwa Kivinji'	20 June 1935
D.262	'Khartoum 1st Visit'	16-18 December 1935 15 February 1936
D.263	'Musmar'	20-22 February 1936
D.264	'Haiya'	24-25 February 1936
D.265	'Sinkat'	27-28 February 1936
D.266	'Suakin'	2-4 March 1936

Research

D.267 'Khartoum 2nd Visit' 11-12 March 1936
10-11 May 1936

D.268 'Unreadable records'

Miscellaneous readings 1, 15 February 1935, 16 March 1936 for stations Morogoro, Babati, Wembe.

D.269 Large folder of 'Latitude and Barometer Heights of Pendulum Stations'.

Observations made at various stations, some dated April, May 1935, in the hands of W. Horsfield and R.N. Lissett of the Tanganyika Territory Survey Department.

D.270 Purple ledger-type book, inscribed 'Pendulum Observations'.

Similar material, by Lissett and another, various dates, April-June 1935.

D.271-D.293 Journals, calculations, writings

D.271 Softbacked notebook labelled 'African Gravity Campaign 1933-34', paginated 1-155 and kept in the hands of Bullard and Margaret Bullard.

Entries run 18 November 1933-26 February 1934 and include detailed accounts of observations, descriptions and maps of stations numbered 1-56.

D.272 Small pocket diary for 1934, with diary entries, calculations, mileage covered, etc., to 1 April. All in Bullard's hand.

Research

D.273 Large blue account book, labelled 'African Gravity Accounts'.

Detailed account of all expenditure incurred before, during and after journey to Africa. Entries run 26 July 1933-31 July 1934, with a final statement of account at end of trip.

This is in many respects one of the most interesting items in the collection, documenting expenses in meticulous detail for personal living, travel, equipment, wages for 'boys', sums 'lost through hole in pocket', etc.

D.274 'Diary of Pendulum Observations at Cambridge, November 1933'

This is a small format notebook, all in the hand of Lenox-Conyngham. Entries run 17 November 1933-22 April 1934 and deal primarily with 'records intended for comparison with those made in Africa'. Occasional other entries are made, e.g. 29 November 'Vening Meinesz visited the Pendulum House', 12 March 'Cable received from Bullard "climbing Kilimanjaro"'.

D.275-D.281 'Coil magnetometer'

Contents of a bulky folder so inscribed, dealing with Bullard's research on terrestrial magnetism conducted at the same time as the gravity observations and with equipment provided by the Carnegie Institution of Washington (see D.146).

Items D.276-D.280 are 'Observer's Cahiers' of the Carnegie Institution, completed by Bullard for five stations only. D.281 is a bundle of observations, descriptions and notes for various stations not distributed into 'Cahiers'.

D.275 Miscellaneous ms. notes and calculations, on results, comparison of various equipment, 'Test on Ordnance Survey coil magnetometer after return from Africa', etc., various dates, December 1933-July 1934.

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D.276	Carnegie Institution Observer's Cahier	no.1
D.277		no.2
D.278		no.3
D.279		no.4
D.280		no.18

D.281 Bundle of loose pages, similar to above, various dates, November 1933-March 1934.

D.282 Tagged sequence of descriptions and summaries of work at all magnetic stations, November 1933-March 1934.

D.283 1p. 'Report on Magnetic Observations in E. Africa, 1933-34', by Bullard.

D.284 Miscellaneous notes and charts for African stations. In original folder, inscribed 'Cambridge Aug. 1935' though material does not correspond with title, and is similar to D.285 below.

D.285 'Attractions Zones'

Miscellaneous notes, diagrams and calculations, comparative tables for East African stations, etc. Perhaps related to Bibliog. 1934.

D.286 'Atbara, Wadi Halfa, Abu Hamad, Meinesz Nos 12 & 13'

Tables and calculations.

Research

D.287 'Uganda Geological Survey'

Correspondence, 1934-37, re Bullard's research and publications on 'Gravity Measurements in East Africa'.

D.288 Shorter correspondence, 1936, re Bullard's paper on gravity measurements.

D.289 'Kohlschütter's Stations'

Extensive folder of tables and calculations, comparing Bullard's observations and results with those of Kohlschütter's expedition of 1899-1900.

D.290 'Hts. Congo Stations'

Tables and calculations.

D.291 'The Structure of the African Rift Valleys'

Ms. and typescript draft for essay submitted for the Sedgwick Prize, Cambridge, September 1936; the draft incorporates sections from Bullard's previously published accounts (Bibliog. 1935, 1936a).

D.292 'Station Diags.'

Plans, drawings, etc. for papers.

D.293 Miscellaneous empty folders labelled for various African stations, data presumably redistributed elsewhere.

D.294 Correspondence, 1956, with Department of Geological Survey, Tanganyika, re their proposed resumption of gravity measurements in East Africa.

There are various shorter items on gravity research in Africa, requests for station maps, information, etc. in Section J.

Research

D.295-D.351 EXPLOSION SEISMOLOGY

This research originated as part of the work in applied seismology at the Department of Geodesy and Geophysics in the mid 1930s. The earliest record of Bullard's involvement dates from 1933 (D.295), but the bulk of the material deals with research from 1935 onwards.

Seismic reflections of small explosive charges recorded on geophones constructed for the purpose were used to measure the depth of the palaeozoic floor, mainly but not exclusively in eastern England (D.301-D.332). Bullard's chief collaborators in this work were C. Kerr-Grant and T.F. Gaskell; the major publication 'Seismic investigations on the Palaeozoic floor of east England' appeared in 1940 (Bibliog. 1940a). The experience thus gained of equipment and methods led to Bullard's being consulted by several industrial firms with an interest in mining or subsidence (D.333-D.340), a connection he frequently referred to in later plans for the postwar organisation and expansion of the Cambridge Department (see esp. B.5-B.9).

What was more important, the work on explosion seismology on land, led to Bullard's being invited to America in 1937 by R.M. Field (D.342) to see the progress of seismic prospecting on the eastern edge of the continental shelf; this was the occasion of his first meeting with Maurice Ewing. As a result, Bullard instigated similar work in Britain to study the western side of the continental shelf. Two expeditions took place, in 1938 from H.M.S. Jason with the cooperation of the Navy, and in 1939 using two Brixham trawlers crewed mainly by amateur yachtsmen. The expeditions were of value in themselves in determining the depth of sedimentation of the continental shelf and also as inaugurating marine geophysics in Britain. The preliminary stages and proposals for the project are documented at D.342-D.348; Bullard's letter of July 1939 in D.348 refers to an additional short expedition in the trawler Arthur Rogers in August 1939 to explore the deep ocean floor.

Of interest is the racy account of the 1939 trip by the skipper of one of the trawlers, published in 1946 and retained at D.350 in a photocopy kindly made available by Dr. D.H. Matthews.

See also E.1.

Research

The material is presented as follows:

Seismic work on land

Apparatus and equipment design	1933, 1935-39	D.295-D.300
Seismic observations and data	1936-38	D.301-D.332
Consultancies	1937-39	D.333-D.340
Miscellaneous later material	1947-56	D.341

Seismic work at sea

	1937-39, 1949	D.342-D.351

Research

Seismic work on land

D.295-D.300 Apparatus and equipment design

D.295 Correspondence re purchase of explosives for planned explosion test, 1933.

This refers to tests on a field seismograph belonging to the Royal Geographical Society and intended for work on thickness of ice in Polar regions, mentioned in the Annual Report of the Cambridge Department for 1932-33 in B.4.

D.296 Drawings for 'Seismic Unit', signed and dated 'E.C.B. 7.vi.35'.

D.297 'Tests of Seismograph Apparatus, 1935-36'

Black hardback notebook so inscribed, belonging to C. Kerr-Grant (a research student of Clare College, Cambridge, who joined the Department in July 1935 to work on applied seismology).

Record of various tests of calibration, sensitivity, etc. on sites in Cambridge and East Anglia, almost all in the hand of Kerr-Grant with an occasional note by Bullard.

Tests run 27 July 1935-8 September 1936, with an incomplete entry for 25 January 1937.

D.298 Grey soft-backed notebook, inscribed with Bullard's name and address and dated 'Dec. 7 1937'.

Entries are almost all in Bullard's hand, and relate to various aspects of geophone testing. Some entries are by T.F. Gaskell. The last dated entry is 17 July 1938.

Research

D.299 'Geophone Design'

Bulky folder of graphs, calculations and narratives, related to various aspects of geophone and to the tests recorded in D.297, D.298, almost all in Bullard's hand and some bearing various dates in 1936 and 1937. Probably related to Bullard's collaborative paper with C. Kerr-Grant 'The design and testing of geophones and their amplifiers' (Bibliog. 1938b).

Includes several paginated sequences by Bullard, one on 'Hydrophone design'.

D.300 'Calculations and lists'

Folder so inscribed but containing similar material to above, calculations, graphs, narratives, almost all by Bullard but some in the hands of T.F. Gaskell and C. Kerr-Grant.

Includes 'List of articles to be taken in van' for seismic survey, dated 27 May 1937, and 5pp. typescript note on 'Seismic Work in Eastern England', n.d. with a ms. note 'Paper prepared by Gaskell for Lord Iveagh who had expressed interest in the Lakenheath work'. (See D.330.)

Probably related to collaborative paper 'Seismic investigations on the Palaeozoic floor of east England' (Bibliog. 1940a).

Research

D.301-D.332 Seismic observations and data, 1936-38

This is a series of folders somewhat similar to those for the African Gravity Campaign. Each has the name of a location, mostly in Eastern England but some in Cornwall and elsewhere. The contents vary, but may include maps, diagrams and descriptions of sites, calculations, narratives and drafts for a report or paper. Most of the work is in the hand of T.F. Gaskell though there are notes and comments by Bullard in almost every folder.

The folders are less meticulously dated than those for Africa and the 'sequence' is therefore presented in the order as received, with a note of any material of special interest.

The folders record the project to measure the depth of the palaeozoic floor.

D.301 'Calvert'

D.302 'Tempsford' some dated 5 August 1937

D.303 'Corby' some dated February 1936, January 1937

Extensive folder, with many notes and calculations by Bullard.

See also D.333.

D.304 'Cornwall Dec. 1938'

Extensive folder by T.F. Gaskell, including 5pp. note on 'Seismic work in Devon and Cornwall December 1938', and 'Story of the Cambridge Seismic Expedition which wintered in the South West Peninsula during December 1938' (journal, photographs, maps).

D.305 'Westmill'

Research

D.306	'Arlesey'	
D.307	'Pertenhall'	
D.308	'Fen Stanton'	
D.309	'Bassingbourn'	
D.310	'Great Staughton'	some dated May, June 1938
D.311	'Meesden'	
D.312	'Duck End'	some dated October 1937
D.313	'Bow Brickhill'	
D.314	'Leighton Bromswold'	some dated November 1937
D.315	'Cambridge'	some dated March, April 1938
D.316	'Brockhall'	
D.317	'Benefield'	some dated July 1937

Extensive folder of calculations and drafts.

D.318	'Feltwell'	
D.319	'Bridgham'	
D.320	'Great Oxendon'	
D.321	'Castlethorp'	

Research

D.322	'Saffron Walden'	
D.323	'Kentford'	some dated August 1936
D.324	'Fulbourn'	
D.325	'Swaffham Prior'	some dated May 1937
D.326	'Madingley'	
D.327	'Bourn'	Includes some comparative data.
D.328	'Charnwood'	
D.329	'Culford'	
D.330	'Lakenheath'	some dated March, April 1938
D.331	'Laxton'	some dated July 1937
	Includes 3pp. ms. narrative by Gaskell.	
D.332	'Upware'	

Research

D.333-D.340 Consultancies

D.333 Stewarts and Lloyds Limited, 1937, 1945

Correspondence and papers re investigation by Bullard and his collaborators of the palaeozoic floor beneath the company's works at Corby. Includes arrangements to conduct investigation and publish results with other seismic data, draft of Bullard's 'Report on Seismic Work at Corby ...' and a ms. draft additional explanatory letter, September 1937.

Also included is a later letter from Bullard about the work, 1945.

See also D.303.

D.334-D.338 Imperial Chemical Industries (ICI), 1937-39

Bullard was consulted by the Company's Alkali division at Northwich, Cheshire, on measuring the shape of cavities full of brine. He made a visit to Northwich to consider the problem, returning later to carry out the required seismic tests.

D.334 Correspondence with R. G. J. Fraser of ICI Alkali Limited, re the consultancy problem, fees, visits to Northwich, etc.

Includes typescript and ms. draft of Bullard's report, and a later letter, 1939.

D.335, D.336 Two reports by Bullard, as presented to the Company's Brine and Water Supplies Executive Committee.

D.335 'Report on proposed method of measuring the shape of cavities full of brine', May 1938.

D.336 'Report on test of seismic method of measuring brine cavities', September 1938.

D.337 ICI report on visit to Company's Winnington Works to discuss work, September 1938.

Research

D.338 Ms. notes, calculations, diagrams, some paginated by Bullard, some in the hand of T.F. Gaskell, some dated August 1938.

D.339, D.340 'Scottish Iron and Steel Company', 1939

Correspondence and papers relating to investigations into the collapse of a chimney, undertaken by Bullard because of his experience with small explosive charges, and using his geophone.

D.339 Correspondence, calculations, drafts of T.F. Gaskell's report, 1939.

D.340 Background papers and reports on subject, sent to Bullard.

D.341 Miscellaneous later material on seismic work on land

1p. circular letter by Bullard re large explosion at Heligoland, 1947.

'Proposed explosions in Canada'

3pp. draft by Bullard (from University of Toronto), 1948.

Note on boreholes in E. Anglia, by F.H. Edmunds, 1955.

'Boreholes at Soham and Wyboston', by T.F. Gaskell, 1956 (comment on the above).

Research

Seismic work at sea

D.342 Folder of correspondence, 1937-39, principally with R.M. Field, re marine geophysical research in America, Bullard's visit, meeting with M. Ewing, subsequent seismic research at sea in Britain in 1938, 1939, etc. Field's letter of February 1939 also refers to Bullard's work on heat flow in South Africa. (See D.359-D.371.)

D.343 Letters from M. Ewing.

No letters from Bullard accompany this correspondence which runs 8 February 1937-1 August 1938, and is concerned with gravity and seismic measurements at sea, equipment and apparatus. Ewing's last letter, which is autograph manuscript, congratulates Bullard very warmly on his 'good work on the shelf'.

D.344 Correspondence and papers, 1937.

Includes Bullard's letter (carbon only) of application to Royal Society for grant to visit America, in response to Field's invitation.

Proposal for seismic research on continental shelf in Britain, October.

D.345 Correspondence, 1938-39, with J.D.H. Wiseman about proposed seismic and gravity research on mid-Atlantic ridge.

D.346 Correspondence, 1938, re equipment and preliminary testing of underwater explosives.

D.347 Correspondence and papers, 1938.

Includes 2pp. note on 'Proposed Seismic and Gravity Work on the Continental Shelf' (no author or date, but probably from Cambridge Department), with comments by W.B. Wright and H.R. Mill, and Bullard's reply.

Research

D.348 Correspondence and papers, 1939.

Includes 2pp. note on 'Proposed Seismic Experiments at Sea', March (not signed, but from Cambridge Department).

Letter from Bullard (carbon only) to Royal Society re investigation of deep ocean floor on short expedition funded from unspent grant for seismic research, July, and correspondence re explosives for the expedition.

D.349 'Seismic work at sea. The constitution of the Continental Shelf'

Extensive typescript draft on work of 1938 and 1939 expeditions.

Miscellaneous ms. diagrams and notes.

D.350 'On the Atlantic Shelf'

Two articles on the 1939 expedition, by Tom Hepworth, Yachting Monthly, 8, July and August 1946. Photocopy made available by D.H. Matthews.

(Hepworth was the part-owner with R.C. Byng of the Arthur Rogers, the Brixham trawler used to carry the explosives. Hepworth himself skippered the second trawler used for the instruments, named by him 'Redcar' and elsewhere named as 'Renown' and 'Terminist'.)

D.351 'Proposals for a geophysical survey of the oceans'

5pp. research proposal + 2pp. list of gear, submitted by Bullard with covering letter to J.D. Cockcroft, August 1949. Mainly related to work on echo-sounding, seismic reflections and seismic refraction to be undertaken on an expedition by M.N. Hill from the Cambridge Department.

Research

D.352-D.426 HEAT FLOW

Heat flow on land, 1937-58 D.352-D.398

With an introductory note

Heat flow at sea, 1951-58 D.399-D.426

With an introductory note

D.352-D.398 HEAT FLOW ON LAND, 1937-58

Bullard's interest is documented from 1937, when he was concerned, in collaboration with A.E. Benfield, with measuring thermal conductivity in boreholes at various sites, and especially in the area of Cambridge (D.352-D.358). In 1938 he accepted an invitation to spend a few months as the first 'guest researcher' at the Bernard Price Institute of Geophysical Research at Johannesburg, where he investigated geothermal heat in South African rocks, working with L.J. Krige (D.359-D.371). During the early years of the Second World War, the thermal conductivity apparatus was reconstructed at Cambridge and used to continue work on the conductivity of rocks from Persia and elsewhere; this work was carried out by Margaret Bullard (D.372-D.378). After the war, Bullard took up the work again with special reference to sites in Britain (D.381-D.389) and Switzerland (D.390-D.393).

D.352-D.358 Early work on boreholes

D.352 Ledger-type notebook, listing boreholes in the eastern and midland counties of England. In various hands. Most of the later entries are by Bullard and many of the earlier entries have annotations by him.

D.353 Miscellaneous notes and drafts, originally stuffed into the front cover of D.352.

Includes data, lists of boreholes, calculations, graphs, narratives, few dated, almost all by Bullard.

Research

D.354-D.357 'Geothermal (Condy of Gault, etc.)'

Contents of a bulky folder so described, and dealing mainly with work on boreholes at Cambridge, 1937-38.

D.354 'Report on the work of the committee for the measurement of the thermal conductivities of rocks', sent to British Association, June 1938 (Bibliog. 1938c).

Two copies, both with ms. corrections or annotations by Bullard.

D.355 Notes, tables and calculations by Bullard on boreholes through gault.

Work runs June 1937-June 1938 and includes summaries of data and tabulated results.

D.356 Graphs, calculations, charts, almost all by Bullard but some in another hand, probably that of A.E. Benfield.

D.357 Brief correspondence with equipment suppliers and engineers re borehole in gault, 1938.

D.358 'Topographic corrn. to heat flow'

Measurements, calculations, miscellaneous notes on various named boreholes in Britain and Europe, some referred to in Bibliog. 1938c.

Two paginated sequences of notes and drafts, 6pp. and 7pp., 'Topographic Correction to Heat Flow in a finite hole'. n.d., c.1937-38.

Research

D.359-D.371 Visit to South Africa

See also D.645.

D.359 Correspondence, 1937-39, from B.J. Schonland (Director, Bernard Price Institute of Geophysical Research), inviting Bullard to visit as the first 'guest researcher' of the newly-established Institute, and discussing research and publications.

D.360 Bullard's letter (carbon only) to Royal Society, requesting permission to take up invitation to Bernard Price Geophysical Institute and outlining proposed investigations, September 1938.

Also included is another letter re temperature measurements.

D.361 Correspondence, 1938-39, from L.J. Krige (Bullard's principal collaborator on South African research).

D.362-D.367 'Geothermal (South Africa)'

Contents of a bulky folder so described.

D.362 Extensive charts and graphs of measurements, all in Bullard's hand.

Ms. notes and drafts by Bullard.

D.363 3pp. 'Abstract' for paper at Royal Astronomical Society, November 1938 (not by Bullard) describing current research on thermal conductivity.

D.364 'Report of Thermal Conductivity Committee' (1938-39). Not by Bullard, but describes work of Bullard, A.E. Benfield, L. Krige, etc.

3pp. with 1p. ms. notes by Bullard on Benfield's work.

D.365 'Why is it hot underground?'

6pp. draft for short lecture given by Bullard during his stay in South Africa.

Research

D.366 Correspondence and data from L.J. Krige, re Bullard's paper Heat flow in South Africa, Bibliog. 1939e. January-June 1939. Krige's letter of 16 January refers to Bullard's 'experiences with the lions'.

Also included is letter from B.J. Schonland.

D.367 Report on 'Cooling of City Deep Mine', by H.L. Callendar, 1923.

D.368-D.371 Notebooks

D.368 Small black notebook, inscribed 'South Africa. E.C. Bullard's Petty Cash'.

1p. only, accounts for November and December 1938. Rest of book contains data, not all in Bullard's hand. Most entries are at back of book.

D.369 Hardbacked notebook, inscribed with Bullard's name, address at Bernard Price Institution, dated November 1938, pages numbered 1-78. Data and calculations.

D.370 Hardbacked notebook, similarly inscribed, dated December 1938, pages numbered 1-46. Data and calculations.

D.371 Hardbacked notebook, similarly inscribed, dated January 1939, pages numbered 1-48. Data and calculations.

Research

D.372-D.378 Thermal conductivities, 1940-41

This was a continuation of the work begun in the 1930s to determine the thermal conductivities of various kinds of rocks, and included specimens from Persia, Scotland and Switzerland. At a time when most of the activity of the Cambridge Department was restricted by the war (Bullard himself being engaged in work for the Admiralty), this research was carried on single-handed by Margaret Bullard with his advice and direction. See the Annual Report for 1941 in B.4 in which her contribution is described as 'The only practical research that has been done in the Department'.

D.372 Spiral-back brown notebook, only 1 page dated (March 1940), mainly by Margaret Bullard with some notes by Bullard and occasional additions from their children. Notes on Persian rocks and on 'Anderson's specimens' (Scottish rocks).

D.373 Black hardback notebook. Similar material, on Persian rocks, all in Margaret Bullard's hand with a date '1940' added later by Bullard.

D.374 Blue hardback notebook. Similar material, on Scottish rocks, all in Margaret Bullard's hand.

D.375-D.378 'Geothermal (Persian)'

Contents of a bulky folder so described.

D.375 Notes, graphs, calculations by Bullard and Margaret Bullard. Includes 8pp. tabulated sequence of tests on 'Conductivity of Rocks', in Bullard's hand, various dates, April-October 1940.

D.376 Correspondence, July-November 1940, from E.M. Anderson to Margaret Bullard, re research and specimens of Scottish rocks.

Research

D.377 Miscellaneous correspondence.

Includes letter from Bullard to his wife, August 1940, setting out method of research, and miscellaneous shorter correspondence not all dated.

Also included is Bullard's carbon letter, 1941, requesting further information on Persian rocks.

D.378 'Report on Geothermal work, 1940-41'

6pp. typescript on results of measurements of 30 Persian and 6 Scottish rocks. By Margaret Bullard, with a few ms. corrections by Bullard.

Brief report on research for 1940-41 sent by Bullard to Royal Society.

D.379-D.398 Later work, c.1944-58.

D.379 Small red notebook of notes on wells and boreholes, some by Margaret Bullard but almost all by Bullard, some pages with various dates, 1944, 1945.

D.380 Blue hardbacked notebook, inscribed 'E.C. Bullard Sept. 1945', graphs, notes, calculations on rocks and boreholes, various dates, 1945-48, includes (at rear) 1p. 'Accounts of work at Wilton July 1946'.

N.B. Both these books are of very mixed content, some referring to work on Persian rocks (see above) and some to Nottinghamshire sites (see below).

Research

D.381-D.389 'I.C.I. & Notts. Temperatures'

Contents of a bulky folder so described.

Continuing work on boreholes, mainly on sites sunk by I.C.I. Limited and by D'Arcy Exploration Company, on sites in Nottinghamshire. The work covers a considerable time-span and includes material dated 1940-51, but is mainly 1946-48.

D.381 Maps and charts of wells provided by I.C.I. and D'Arcy Exploration Company and mainly dated 1943-45. Many annotated by Bullard.

D.382 Notebook of 'Experimental data'.

Few entries only, 1940, 1944, on Nottinghamshire and Yorkshire wells.

D.383 Small blue notebook of data and calculations. Both ends of book used. Most entries dated 1948.

D.384 Certificates of thermometer tests, 1946.

D.385 Extensive notes, charts, tabulated data, etc., all by Bullard. A few pages bearing various dates, 1944-51.

D.386 Correspondence with I.C.I. re project, arrangements to visit and measure boreholes, etc., 1946-49.

D.387 Correspondence with D'Arcy Exploration Company on subject, 1946.

D.388 Shorter correspondence on boreholes, 1944-46. Includes data.

D.389 Shorter correspondence on conductivity, etc., 1950-51.

Includes data and letter from E.R. Niblett on collaborative paper on thermal conductivity (Bibliog. 1951e).

Research

D.390-D.392 'Geothermal (Swiss)'

Contents of a folder so described.

Continuing work on conductivity, 1947-51.

D.390 Maps and charts of sites studied in Switzerland, most annotated by Bullard.

D.391 Notebook of sites and specimens in Switzerland, few pages used, dated September 1947.

Miscellaneous ms. notes and diagrams.

D.392 Correspondence and data from E.R. Niblett, 1950, 1951.

Includes list of conductivity measurements on Swiss rocks, charts, etc., some annotated by Bullard.

D.393 Bullard's tagged folder of correspondence with E.R. Niblett, March 1954-October 1955, on thermal conductivity of Swiss rocks, research and publication. Includes Bullard's ms. data of conductivities in Simplon Tunnel (taken in 1947).

D.394-D.396 'Geothermal Odds and Ends'

Contents of a folder so described.

D.394 Miscellaneous ms. notes and calculations by Bullard, variously paginated, some dated 1948, 1949.

D.395 Correspondence with colleagues, on conductivity, 1946-49.

D.396 Research notes, reports, etc. by others.

D.397 Later shorter correspondence on boreholes, 1956, 1958.

D.398 Notes, calculations, diagrams, apparently on effect of snow cover on heat flow, n.d. but folder contains paper on similar topic by L.W. Gold, 1957.

Research

D.399-D.426 HEAT FLOW AT SEA, 1951-58

Bullard's first work on marine heat flow was at the Scripps Institution of Oceanography in 1949 (see Section C. passim but especially C.12-C.14). The continuation of his collaboration with A.E. Maxwell at Scripps and with E.R. Niblett at Toronto can be seen in correspondence at D.406, D.415.

Most of the material below is concerned with the construction of apparatus, its use during sea-going expeditions and the analysis of results 1950-58, when Bullard was at the National Physical Laboratory and then at Cambridge.

For logs and accounts of expeditions on R.R.S. 'Discovery II' during and after this period, see Section B.

Titles and descriptions on the folders have been retained and appear in inverted commas (not always in Bullard's hand); the contents of bulky folders have sometimes been sub-divided for ease of reference, and very decrepit folders have been discarded.

D.399-D.403 Notebooks, 1951-56, 1958

All these are similar hardbacked books with alternate graph and lined pages, almost all in Bullard's hand with occasional interleaved or pasted-in additions. The first four are National Physical Laboratory books, the last is from the Cambridge Department.

The content consists of notes, diagrams, measurements, procedures, analyses of results, in preparation for and in the course of sea-going expeditions.

D.399 Inscribed 'Heat flow at sea. Book I'.

Pages numbered 1-72. Entries run 5 June 1951-December 1952.

D.400 Inscribed 'Heat flow at sea. No.2'.

Pages numbered 1-49. Entries run 28 August-September 1952 with later additions, 1961, on pp.48-49.

Research

D.401 Inscribed 'Heat flow at sea (book 3)'

Pages numbered 1-71. Entries run 9 July-November 1954.

D.402 Inscribed 'Sea work 1956'

Entries run 16 June-27 August 1956. Back page has notes dated 30 November 1958.

D.403 Inscribed 'Heat flow at sea. Book 5. Sea work 1958'

Pages numbered 1-40. Main entries run 12 June-19 October 1958. In more than one hand, some by Belinda Bullard.

D.404-D.409 'Geothermal sea'

Contents of a bulky folder so described, the folder itself being too decrepit to be retained.

The material covers a considerable time-span (1949-54) and includes information or correspondence from colleagues in U.S.A., Canada and Japan as well as from various divisions of N.P.L. There are also Bullard's own extensive notes. There is considerable overlap with other folders, but Bullard had kept this material as a unit.

D.404 Notes, diagrams and drafts on design of apparatus and evaluation of results. Almost all by Bullard, but not dated or paginated.

D.405 Shorter ms. notes and information sent to Bullard.

Includes notes on 'Thermal Conductivity Apparatus' from Earthquake Research Institute, Japan.

D.406 Correspondence from colleagues.

A.E. Maxwell	1949
E.R. Niblett	1949
L.H.N. Cooper	1953
unidentified	1951

Research

D.407 Reports and correspondence from colleagues at N.P.L.

Test results	1952
Report on 'Deep Sea Thermometer'	1953
Test results of 'T'	1953
'Heat Conduction Problem'	1953

D.408 Reports on the analysis of Atlantic floor sediments, sea-bed clays and fused silica, mainly from E.H. Ratcliffe, 1953-54.

D.409 Photographs of apparatus, and of observations.

D.410 Two diagrams of 'Ocean bed temperature measuring apparatus', drawn by Metrology Division, N.P.L., no.1877. n.d.

D.411-D.413 Reports and correspondence re apparatus, from N.P.L.

D.411 'Sea-bed apparatus' 1951

D.412 'Tests on a Deep Sea Thermometer', N.P.L. Report 1953

D.413 'Experiments to find the Best Adhesive for Attaching a Galvanometer Mirror to its Support'. Draft for N.P.L. Report. 1955

D.414 Shorter correspondence with suppliers re equipment. 1954-58

D.415 'Heat Flow Work at Sea, July 1952 "R.R.S. Discovery II"'

Tagged folder of correspondence and papers re organisation of expedition, supplies, programme of research, Bullard's letters of thanks.

D.415A Bullard's letter to R. Revelle, 30 June 1952, re apparatus, forthcoming 'Discovery II' expedition, etc. Includes press-cuttings.

Photocopy of originals in Archives of the Scripps Institution, kindly made available by the Archivist, April 1984.

Research

D.416 'Bottom Temperature Measuring Apparatus'

Tagged folder of correspondence and papers, 1953-54. Includes 2 copies of Bullard's 'Notes on Bottom Temperature Equipment', n.d. but probably intended for M. Ewing to whom the apparatus was lent in May 1953; miscellaneous correspondence with firms re repairs and supplies; correspondence with colleagues and others re expedition on 'Discovery II' in November 1954.

D.417 'Thermal Conductivity Work (Mr. E.H. Ratcliffe)'

Tagged folder of correspondence, graphs, reports, etc. on ocean floor sediments (1955) and on fused silica discs (1954).

D.418 'Heat flow 1954'

Calculations, graphs, etc. all by Bullard.

D.419 'Thermal Conductivity Ocean Seds.'

Calculations, graphs, etc., some comparing 1952 and 1954 results, most dated 1955 and including 1p. graph dated 1960.

D.420 Untitled folder of notes, calculations and graphs, all by Bullard, some paginated.

n.d. but includes note on 'Heat flow problem', by G.F. Miller and report on thermal conductivity by E.H. Ratcliffe, both dated 1955.

D.421 'Heat flow 1956'

Extensive calculations and graphs for samples taken on 1956 'Discovery II' expedition.

Folder includes 1p. dated 1954, 1p. dated 1960, and some computer data.

Research

D.422 'Heat flow 1958'

Calculations, graphs, etc. (almost all by Bullard) on samples taken on 1958 expedition.

D.423, D.424 'Heat flow 1954-58 (general papers)'

D.423 Notes, graphs, calculations, mainly comparing results of observations in 1954, 1956, 1958.

Includes letter from A.S. Laughton on expedition data, 1958.

D.424 8pp. 'Calculations for paper on Moho temps. June 1961', originally included with above.

D.425 'The flow of heat through the floor of the Atlantic Ocean', by Bullard and A. Day.

Typescript draft with ms. corrections by Bullard, drawings, etc. for paper (Bibliog. 1961a).

D.426 Annual Report, Volcanological Research Department, 1956-57 (sent for information).

Research

D.427-D.429 AIRBORNE MAGNETOMETER, 1947

D.427 'The compensation of an airborne magnetometer for the magnetisation of the aircraft'

13pp. typescript and ms. report by Bullard, not dated but using the calculations and formulae of D.428 below.

D.428 'Corrn. of Airborne Magr.'

7pp. ms. calculations dated '1/1947'.

There is no indication of the origin or destination of the report, but it would seem to form part of the 'Early History' referred to in Bullard's report to the Ministry of Supply in 1957 (see E.169).

D.429 Report on 'Surveying from the air', produced by Photographic Survey Corporation Airborne Profile Recorder, Toronto, 1949.

D.430-D.433 FIGURE OF EARTH, c.1947

Notes and calculations relating to methods of determining the ellipticity of the Earth, using variation of g with latitude, the Moon's parallax, triangulation, etc.

D.430 1p. (only) 'Contribution to RAS discussion on the Figure of the Earth' (perhaps Bibliog. 1948a).

Paginated sequences of notes and calculations, pp.1-22, pp.1-22, pp.2-7.

D.431 Shorter unpaginated notes and drafts. In original folder inscribed 'Figure of Earth'.

D.432 'The application of the International Figure of the Earth to the different countries surveys and maps'

6pp. typescript and ms. report sent to Bullard, n.d., relating to D.433.

D.433 Translation of 'Commander Schmidt's paper'.

60pp. typescript, n.d., referred to especially in ms. addition to D.432 above.

Research

D.434-D.476 DYNAMO THEORY, 1947-79

The earliest documents date from 1947 when Bullard was at Cambridge immediately after the Second World War. The work continued at Toronto and then at the National Physical Laboratory. Several publications resulted during the 1950s, in particular with H. Gellman in 1950, 1954.

Although Bullard consulted members of the NPL staff and other colleagues, and also made use of the ACE computer at NPL, it is noteworthy that virtually all the calculations and graphs in the folders - for what he himself described as a 'long and elaborate paper' (see A.7) - are in his own hand, and most of the calculations submitted by others are checked or corrected by him.

The material was received crammed into folders or filing-drawer dividers with only a summary indication, usually 'Dynamos 1950-54'. The contents are now sub-divided for ease of reference though the contents of each named section are respected and preserved as such; this has sometimes resulted in an overlap of material, but it was thought best to retain Bullard's overall divisions. Paginated sequences of notes are preserved, but many loose pages remain.

Bullard continued to investigate and publish on dynamos; see D.474-D.476 for later work on disc dynamos.

D.434-D.438 'Rotating Spheres'

Contents of a bulky folder so described.

D.434 Extensive sequence of notes and calculations, paginated 1-46 with many intercalations.

D.435 Shorter sequence 'For sphere', paginated 1-5.

D.436 Shorter sequence 'For cylinder', paginated 1-3.

Research

D.437 Similar material, not paginated but usually with heading or indication of content.

D.438 Calculations and graphs, some on University of Toronto paper.

In original folder.

D.439 'Dynamos 1950-54'

Extensive folder of drafts, calculations and graphs, all in Bullard's hand except for a few printouts with his note 'tabulated by ACE' (The Automatic Calculating Engine at NPL).

The material is paginated 1-156 with a very few pages missing and many intercalated pages. There is a rough ms. index for pp.1-140. The work is not dated, but some of the ACE printouts bear various dates in 1951. There are some unnumbered pages and graphs at end.

All in original folder.

D.440-D.444 'Dynamo Theory 1950-54'

Contents of a bulky folder so described.

D.440 Paginated sequences of notes and drafts. Includes photocopies of his two short papers on spherical dynamos of which the originals are at D.449, D.450.

D.441 Unpaginated sequences of calculations. Includes 1p. chart of 'Prelim. results' and extensive bundle of calculations and notes dated 8 May 1953 with a note 'These are believed to be final results'.

D.442 Unpaginated sequences, mainly graphs and tabulations.

D.443 More fragmentary notes, graphs and calculations.

In original folder.

Research

D.444 Correspondence and data from colleagues, 1951-53. Mainly from NPL, but includes letter from G.K. Batchelor on his and Bullard's views on dynamos (April 1953).

D.445-D.448 'Earth's non-dipole field ...'

Contents of a bulky folder so described.

D.445 Correspondence with H. Gellman on research and publication, January-March 1950.

Includes data.

D.446 Notes, calculations, graphs by Bullard.

D.447 Tables of calculations in another hand, several annotated or with additions by Bullard.

D.448 Tables of data on non-dipole field, typescript and numbered 1-6 by Bullard.

In original folder.

D.449-D.464 'Dynamos 1950-54'

Contents of folder (now at D.456) and of filing-drawer divider so described: a very extensive assembly of material, some dating from 1947, now sub-divided for ease of reference.

D.449 'On the impossibility of a liquid sphere acting as a dynamo'

6pp. pencil draft.

D.450 'On the possibility of spherical dynamos'

13pp. pencil draft, commenting on above.

These two notes by Bullard form the basis of much of his work on dynamo theory and photocopies of part or all of them were included by him in several other folders.

Research

Paginated drafts and sequences.

D.451 2pp. 'Boundary conditions'

13pp. 'Resistance of core for dynamo paper', etc.

24pp. calculations.

D.452 15pp. calculations

22pp. calculations

5pp. calculations

D.453 6pp. calculations

13pp. calculations

11pp. calculations

D.454 17pp. calculations

11pp. calculations

D.455 Miscellaneous pages of calculations, some with page numbers, but not forming a sequence.

Ms. diagram for sphere and cylinder.

Table of results - 'Prelim. - not to be believed'.

D.456 Extensive loose pages of diagrams, charts, calculations and drafts, some with headings, a few with page numbers.

In original folder.

Research

D.457-D.463 Correspondence with colleagues and collaborators, 1947-53.

In alphabetical order.

Several of the early letters refer to P.M.S. Blackett's paper 'The magnetic field of massive rotating bodies' (Nature, 159)

D.457	Batchelor, G.K.	n.d.
	Blackett, P.M.S.	1948, 1949
	Chapman, S.	1948
D.458	Elsasser, W.M.	1948, 1949
	E.T.G.	n.d.
D.459	Gellman, H.	1950
	Includes report on 'spherical dynamo problem'	
D.460	Hales, A.L.	1947
	Gravity and magnetic research in South Africa.	
D.461	Hartree, D.R.	1949
	Inglis, D.R.	1949
	Mott, N.F.	1948
	On thermal conductivity, but with Bullard's heading 'file geomag.'	
D.462	Olver, F.W.J.	1952
	Runcorn, S.K.	1947, 1949 (Bullard's carbon only)
	Vestine, E.H.	1948
D.463	Woodger, M.	1952-53
	Mainly re results of calculations made in NPL Mathematical Division, but includes Bullard's 'Child's guide to results in dynamo problem'.	

Research

D.464 'Suggestions to the authors'

10pp. typescript detailed comments on paper submitted for publication. No author or date, but perhaps refers to paper with Gellman (Bibliog. 1954e). Very heavily annotated by Bullard.

Included here are pp.14-18 of draft paper, with many ms. additions and corrections.

D.465-D.468 'Eigen Values'

Contents of a folder so described. Mainly notes and drafts for a paper arising from problems of calculation involved in dynamo theory.

D.465 'Real eigen values of certain linear differential equations'

13pp. ms. draft, very heavily corrected, n.d. but 1p. draft references lists Bullard's paper Bibliog. 1954e.

In original folder.

D.466 6pp. earlier draft for paper, same title.

D.467 28pp. and 2 unnumbered pages, drafts and calculations.

D.468 Shorter drafts, calculations and notes.

N.B. No separate paper of this title is listed in the Bibliography.

D.469-D.471 'Disc Dynamo 1954-5'

Contents of a folder so described.

Paginated drafts and calculations by Bullard.

D.469 25pp. headed 'Disc Dynamo', May 1954.

Research

D.470 7pp.

4pp.

3pp.

3pp. tables 'Comparison of ACE and DA Solutions', by Bullard, comparing methods of solving problem by computer and by differential analysis.

D.471 Charts, diagrams, printouts (annotated).

Correspondence and information from members of NPL staff, 1955.

In original folder.

D.472 Drawing 'To illustrate Bullard's theory of the earth's magnetic field', with various notes and queries. No author or date, but refers to model with 'magnetic axis coincident with rotational axis'.

D.473 'Oscillating dynamos'

Miscellaneous research material. Includes three sets of paginated notes by Bullard, and three sets of notes by others, one dated 1967.

D.474-D.476 'Dynamo Theory'

Contents of a folder so described.

D.474 Research data, from 'Program LOOKSE', in collaboration with D. Gubbins at Scripps, some annotated by Bullard. Various dates, January-March 1975.

D.475 Correspondence with D. Montgomery, 1978.

Includes two ms. notes by Bullard, on 'Two-dimensional dynamos' and 'Non-existence of a dynamo with a two-dimensional magnetic field'.

D.476 Correspondence with colleagues, 1979.

Research

D.477-D.483 EARTH DENSITY, c.1951-56

The folders cover various topics such as temperatures in the earth's core, resistivity of molten iron, seismic velocities. Some of the material is related to publications, in particular to Bullard's contribution 'The Interior of the Earth' to The Solar System, ed. G.P. Kuiper (Bibliog. 1954g).

See also G.30.

D.477-D.479 'Solar System Chap.2'

Contents of a folder so described. (The reference is to Bibliog. 1954g.)

D.477 Very extensive calculations, charts and diagrams on earth's mantle, core, etc. all by Bullard, n.d.

In original folder.

D.478 Correspondence and data from colleagues; dated letters are all 1952.

In alphabetical order.

D.479 Miscellaneous photographs of seismic velocities, various dates, 1948-51 (not by Bullard).

D.480 Untitled folder of notes and drafts on the melting point of iron.

Includes 2pp. ms. draft by Bullard 'The melting point of iron at high temperatures', and miscellaneous notes on the subject by members of NPL staff, various dates, 1951, 1952, 1955.

Research

D.481-D.483 'Density in Earth'

Contents of a folder so described, mainly relating to testing of theories of H. Jeffreys and others on seismic velocities and density in earth.

D.481 Extensive notes, charts, diagrams by Bullard.

includes 26pp. sequence on 'Constants adopted'. Some of the diagrams bear various dates, 1955, 1956.

In original folder.

D.482 Printouts, all headed and some annotated by Bullard, c.1956, done on NPL Computer. A letter from Bullard, included in the folder, to Superintendent, Mathematics Division, explains his research and wish to use 'Pilot ACE or DEUCE to get solutions of the equations connecting the seismic velocities and density within the earth' (June 1955).

D.483 Correspondence and data from B. Gutenberg on velocities, and notes and calculations by Bullard arising, 1955.

Research

D.484-D.506 PROTON MAGNETOMETER, 1956-66

Most of this work derives from research expeditions in R.R.S. 'Discovery II' (in 1956 and 1958) and in 'Sarsia' (1957). (See also expedition reports in Section B.) The material continues to 1966.

The material, which includes printouts of computer data as well as Bullard's manuscript accounts, notes and calculations, was received in filing-drawer dividers and there are in consequence fewer original folders.

D.484 Chart of 'Discovery II' expedition, July-August 1956, showing observation stations for the various research projects undertaken. With several annotations by Bullard.

D.485 Listings, 10pp. and 6pp., of observations off Brittany and in Channel, August 1956.

D.486 Bullard's list of tapes made on 1956 expedition, of work to be done on them, notes on computer data, ms. charts and graphs based on tapes, etc.

D.487 'Abstract of Navigator's Notebook'

10pp. ms. notes and calculations by Bullard.

D.488 'Extracts from rough log 16/8/56'

4pp. ms. notes and calculations by Bullard.

D.489 'Astronomical Observations'

8pp. ms. notes and calculations by Bullard, July-August 1956.

D.490 Miscellaneous notes, diagrams and calculations on 1956 expedition, and magnetometer survey.

Research

D.491 Extensive folder of computer printouts of various measurements on tapes of 1956 expedition.

All the printouts are headed, and many are annotated or checked by Bullard. Some are dated December 1959.

D.492-D.496 'Heading Correction'

Contents of a filing-drawer divider so labelled. Mainly comparative data based on expeditions of 'Discovery II' and 'Sarsia'.

D.492 'Effect of ship's heading on magnetometer'

12pp. ms. draft.

D.493 Drafts, diagrams and calculations on subject. Pages numbered 1^a-32 with many intercalated pages, mainly on 1956 expedition.

D.494 Miscellaneous ms. diagrams of proton magnetometer readings, most dated July 1956.

D.495 Similar but more extensive material, mainly relating to readings on 'Sarsia' expedition, 1957, and comparison with 1956.

D.496 Similar, shorter material, for 1958 expedition.

D.497 Bullard's list of 100 magnetic tapes made on 1958 'Discovery II' expedition, with details of time, place and comment on content.

Miscellaneous ms. notes re tapes, 'Things to be checked', annotated printout.

Two diagrams of readings, May 1958.

D.498 Calculations and charts on magnetometer readings from 1958 expedition, almost all by Bullard.

Research

D.499 Calculations and printouts on 'Daily variation', May-July 1958.

D.500, D.501 'Magnetics Atlantic 1958'

Contents of a folder so described.

D.500 Ms. charts and diagrams by Bullard.

D.501 Printouts, some annotated by Bullard, mainly magnetic reductions.

D.502 Similar material - printouts of magnetic reductions for 'Discovery II' and various stations, May-July 1958.

D.503 Notes and diagrams by Bullard, mainly on secular variations.

D.504 Spring-back folder of notes, calculations and printouts, not all in Bullard's hand.

Folder is labelled (in another hand) 'Fit Function - Atlantic. Determination of Regional Gradient for North Atlantic'. Material related in part to collaborative paper with M.N. Hill and C.S. Mason 'Chart of the total force of the earth's magnetic field for the north-eastern Atlantic Ocean' (Bibliog. 1962b).

D.505 Shorter correspondence from colleagues forwarding data for magnetic research, 1956-62.

Correspondence with colleagues on magnetometer design, 1957, 1959.

Correspondence with manufacturers re costs of supplying magnetometers, 1960, 1963.

D.506 Later observations, diagrams and printouts, mainly by Bullard or annotated by him, various dates, 1965, 1966, re computer program to reduce data from a proton magnetometer.

Related to, and including a copy of, a paper describing the program, by J. Bath, dated 7 October 1966.

Research

D.507-D.513 SEISMIC REFLECTION/APPLIED SEISMOLOGY, 1956-58

Most of the material was received in a filing-drawer divider labelled 'Seismic Reflexions'. See D.351 for a research proposal on the subject by Bullard in 1949.

D.507-D.510 Research proposals by Bullard:

D.507 'Research in applied seismology'

6pp. typescript and ms., October 1956.

D.508 'Appendix to "Research in applied seismology"'

5pp. typescript and ms., December 1956 (2 copies).

D.509 'Computation of reflexion seismogram from geological structure'

3pp. typescript and ms. note based on appendix above, n.d.

D.510 'The evaluation of the Fourier integral representing the ground motion due to reflected waves'

4pp. typescript and ms. note improving on above, March 1957.

All in original folder.

D.511 Correspondence with colleagues at Shell Laboratories, Delft, who were collaborating in the work, December 1957-April 1958.

Included here are computer data found with the correspondence, copies of Bullard's EDSAC programs for seismic reflection, 6pp. ms. notes and related offprints.

Research

D.512 Extensive folder of ms. notes, graphs, calculations.

Includes computerised data, all headed, annotated or checked by Bullard.

D.513 'Projection of fields'

Two sequences of ms. notes by Bullard so described, 8pp. and 9pp., and miscellaneous shorter loose pages.

Research

D.514-D.517 ARGON DATING, 1956-61

This was part of an investigation into the earth's atmosphere in the past, analysing argon in rock salt and atmospheric argon. The test data were computed on a program written by Bullard for the EDSAC machine. Most of the correspondence requesting samples or discussing results dates from 1959 and 1960, but see letter from T.R. Scott on the project, April 1956, and Bullard's letters to H. Borchert, May 1958.

D.514, D.515 Correspondence with colleagues, firms, etc., requesting samples and discussing research.

D.514 A - H

D.515 I - S

D.516 Draft programs by Bullard for processing argon data on EDSAC computer.

11pp. n.d.

Test printouts, some dated 1961.

D.517 'EDSAC'

Ms. notes and calculations, test printouts annotated and checked by Bullard, most dated 1960.

In original folder.

Research

D.518-D.522 SECULAR VARIATION, c.1958-59

Contents of a filing-drawer divider so labelled. Very little of the work is dated; some of the paper format used by Bullard in his notes and drafts is similar to that used at the N.P.L. in the 1950s, and may originally have been part of the 'Dynamo Theory' material, but the draft paper at D.522 is 1959 or later.

Bullard's Chree lecture, 'The secular variation of the Earth's magnetic field', was published in 1958 (Bibliog. 1958a). A collaborative paper with D.W. Allan, 'Origin of the secular variation' is listed as 'abstract only' (Bibliog. 1960c); the paper at D.522 is unlisted.

See D.146, D.275-D.281 for Bullard's first work on secular variation in 1933-34.

Miscellaneous ms. notes and calculations by Bullard.

D.518 31pp.

D.519 4pp.

7pp.

3pp.

7pp. (later work)

D.520 Miscellaneous unpaginated notes, diagrams, calculations.

D.521 Research notes and information provided by collaborators (more than one hand).

D.522 'The Secular Variation of the Earth's Magnetic Field'

7pp. typescript and ms. draft for paper by D.W. Allan and E.C. Bullard, n.d., latest reference 1959, not listed in Bibliog.

Research

D.523-D.576 COMPUTER APPLICATIONS, c.1959-76

EDSAC c.1959-62

BOMM c.1960-76

The presentation and dating of this sub-section are somewhat artificial, since Bullard had been interested in mechanical methods of calculation and data-processing from very early in his research career. Some of the work on explosion seismology during the 1930s was processed on an early adding-machine, and Bullard himself was active in designing automatic recording instruments for gravity measurements. Similarly, many of the folders for research projects of the 1950s contain work making use of the computer resources of the National Physical Laboratory and the University Mathematical Laboratory at Cambridge.

It is nevertheless the case that during the 1950s Bullard came increasingly to seek ways of automatically reducing large quantities of observational data, and thus to write his own programs, using the Cambridge EDSAC machine. Later, in collaboration with colleagues at the Scripps Institution he shared in the major project known as BOMM for time-series analysis.

D.523-D.527 EDSAC c.1959-62

This was the computer (Electronic Delay Storage Automatic Calculator) developed and built at the University Mathematical Laboratory, Cambridge. Bullard used it to process much of the data from the 'Discovery II' expeditions and other research projects during the 1950s. He wrote several programs himself, descriptions of which are retained at D.525.

D.523 'Least Squares'

2 ms. draft programs for EDSAC, 4pp. (dated May 1959), and 3pp.

Miscellaneous test printouts for program, June 1959.

Included here is a copy of the instructions for the completed program, another copy of which is included in D.525.

Research

D.524 Correspondence, 1960, re 'magnetic programme' at University of Durham, with 7pp. ms. notes and calculations by Bullard using Durham program.

D.525 Tagged folder of 'EDSAC PROGRAMS', containing 18 descriptions of programs by Bullard, as follows:

1. Attractions
2. Sum Series
3. Fit function
4. Read or punch alpha-numeric characters
5. Reduce magnetometer (4 BP) and (5 BP)
6. Power spectrum
7. Read magnetometer
8. Difference magnetometer
9. Check magnetometer
10. Total field
11. Daily variation
12. Remove trend (1)
13. Seismic reflection (2B)
14. Remove trend (2)
15. Field from count
16. Least squares (1) and (2)
17. Argon (1)
18. Seismic reflections (1) and (1x)

The folder has a ms. note 'about 1958', though probably some of the work is rather later.

D.526 Copies of nos. 7, 9, 16, 17 with alternative material from above, perhaps earlier or later versions.

D.527 Two additional programs not included in D.525.

'Proton Precession', 3pp., dated December 1962.

'Short description of the programme "Seismic Reflection (3)"', 2 pp., n.d.

Research

D.528-D.576 BOMM, 1960-76

This was a program for time-series analysis. Its name is derived from the initials of those principally involved: B(ullard), O(glebay), M(unk), M(iller). The acronym makes clear the collaborative nature of the work, which was funded by American research grants and conducted chiefly at the Institute of Geophysics and Planetary Physics, Scripps Institution of Oceanography, University of California (see Section C).

A 'User's Guide to BOMM ... preliminary version' appeared in 1962, followed in April 1964 by a revised version and a second edition in January 1966. Bullard's copy of the 1966 version is included at D.560.

In a short biographical sketch of Bullard (Earth-Science Reviews, 4, 1968), D. Davies writes:

> '... in collaboration with a group from Scripps Institution ... he developed a 'super-program' for time-series analysis, reducing the programmers effort from the punching of thousands of cards to the punching of tens. He didn't just act as genial overlord to the project - he took an equal share in the programming, punching and testing. Anyone wanting evidence of his mischievous sense of humour need only borrow the program and try and insert a time series including the non-existent days when we changed calendar in the eighteenth century. The result is surprising.'

The surviving material corroborates this account of the active part played by Bullard throughout, including his joke program for the calendar change in 1752 (see D.558). There are two principal sections: Bullard's own draft programs and notes (D.528-D.559) and the correspondence with colleagues 1960-76 (D.561-D.576).

The correspondence, as well as complementing the notes and drafts for the 'User's guide', continues after publication and includes comments by other laboratories and institutions using or adapting BOMM on various machines. At a later stage (see D.569 et seq.), BOOM was developed; see D.574-D.576 for 'thoughts' and notes on this by Bullard, 1968, 1976.

See also E.21.

Research

D.530 'Check'

Extensive folder of notes, narratives and programs, almost all by Bullard, a few in the hand of F.E. Oglebay.

Some dated July, September 1963, November 1964, and includes 48pp. ms. sequence for various 'Check' routines.

D.531 'CHGVAR'

2pp. only, ms. draft program by Bullard.

D.532 'CONVL'

3pp. ms. draft program by Bullard.

D.533 'Subroutine CYCLE'

Notes, narratives and programs by Bullard, some dated August, September 1960, April 1962.

D.534 'END'

Notes, narratives, draft program by Bullard, some dated August 1960, March 1962 (by F.E. Oglebay).

D.535 'ERROR'

Notes, narratives, draft program by Bullard, none dated.

D.536 'INSERT'

2pp. only draft program, dated November 1961.

D.537 'INTPL'

Notes, calculations, draft program by Bullard, some dated September 1962.

Research

D.538 'FETCH'

Notes, programs, printout, some dated August 1961 and several in the hand of F.E. Oglebay.

D.539 'Subroutine LET'

Narratives and programs by Bullard, August 1960, February 1962.

D.540 'LIBR'

Notes, narratives, programs, various dates, August 1960-April 1964, some in the hand of W.H. Munk.

D.541 'NUB'

Extensive folder of notes, narratives, programs, test printouts, various dates, September 1960-April 1962, mostly by Bullard, but a few in the hand of F.E. Oglebay.

D.542 'NUM'

Notes, narratives, test printouts by Bullard, mainly dated August 1960.

D.543 'OPER'

Ms. notes and draft programs by Bullard.

D.544 'OPTION'

Narrative, notes, draft program by Bullard, August-September 1960.

D.545 'OUTPUT'

Notes, narrative, draft programs by Bullard, dated December 1961, January 1961 (perhaps an error for 1962).

Research

D.546 'PRERROR'

Notes and draft program by Bullard, August 1961.

D.547 'Subroutine RE'

Miscellaneous notes by Bullard.

Computer printout June 1964, with ms. note by Bullard 'Test of revised RE. Works correctly'.

Also included is letter, 1960, from D.P. Moore, about this subroutine.

D.548 'READ 1'

Notes, charts, draft programs by Bullard, one dated August 1961.

Includes letters from F.E. Oglebay, December 1960, January 1961.

D.549 'READ, WRITE ETC.'

Extensive folder of notes and drafts by Bullard, several dated May 1961; draft programs by Bullard and D.P. Moore, May-July 1961; several test printouts annotated by Bullard (some programmed to produce text of 'Good King Wenceslas').

D.550 'RERROR'

Notes and programs by Bullard, only two dated (November 1961, January 1962).

D.551 'RESUME'

1p. only, dated March 1962, in the hand of F.E. Oglebay.

D.552 'SBERP'

Notes, narratives, draft programs by Bullard (dated May 1962). Test printouts annotated by Bullard, n.d.

Research

D.553 'SEV'

Notes and draft programs by Bullard, dated December 1960.

D.554 'STARTING DECK'

1p. only ms. draft program by Bullard, n.d.

D.555 'STRSER'

1p. only ms. draft annotated program by Bullard, May 1961.

D.556 'TEATYM'

1p. draft program by Bullard.

2pp. draft program in the hand of F.E. Oglebay, dated March 1962.

D.557 'TIM'

Narratives, notes, draft programs, all by Bullard, some with various dates, March and October 1961, January 1962.

D.558 'TNAME'

Miscellaneous notes and draft routines by Bullard, some dated January 1962, April 1964.

Includes page headed 'Joke about 1752', a reference to Bullard's program for the calendar change of that year. See the article by D. Davies in Earth-Science Reviews, 4, 1968, quoted in part in the introductory note to 'BOMM' above.

D.559 'TRANSF'

2pp. ms. draft routines by Bullard, n.d.

Research

D.560 'A User's Guide to BOMM'

Bullard's own initialled copy of the version published in January 1966.

D.561-D.576 Correspondence on BOMM and BOOM

Bullard was based in Cambridge for most of the academic year while the other members of the BOMM team were at the Scripps Institution. There is therefore unusually full documentation for the development of BOMM and its programs. The principal correspondent is Florence (Flicka) E. Oglebay (later Dormer), with whom letters are exchanged sometimes several times a week in bursts of activity over a particular problem. On the other hand, there are total gaps for the periods when Bullard was himself resident at Scripps.

The main theme is the development of BOMM, its use, and its successor, BOOM; in letters exchanged with W.H. Munk there are also references to other research projects, expeditions, Bullard's posts at Scripps, etc.

Some of Bullard's own notes and draft programs, similar to those in the main sequence at D.528-559 above, also appear occasionally in the correspondence.

D.561 1960, December only.

1961, August-December

D.562 1962, January-May

D.563 1962, June-December

Bullard's letter of 31 December to a prospective user explains the state of the project and the machines for which versions of BOMM were to be produced.

D.564 1963, January-June

Research

D.565 1963, July-December

Includes correspondence, July, re adapting BOMM for Titan.

D.566 1964

Includes correspondence with users of BOMM on adaptations for other machines and languages, and correspondence with collaborators re 'User's Guide' and modifications required. An extensive folder.

D.567 1965

D.568 1964-68

Correspondence with G.W. Lennon on the use of BOMM at IBM Data Centre and elsewhere.

See also E.60.

D.569 1966-67

Letter of January 1967 explains the origin of BOOM (Bullard, Oglebay, Oglebay and Munk).

D.570 1967-68

Correspondence re use of BOMM at Atlas Computer Laboratory. Letter to Bullard of 19 December speaks in very favourable terms of the value of BOMM as an analytical tool in power system problems.

D.571 1968

Includes correspondence on possible use of BOMM at Tata Institute, Bombay, and at CERN; also on development of BOOM, the CDC 3600 version of the successor to BOMM.

D.572 1969

Includes various draft papers for BOOM, copy of 'User's Guide to BOMM on Atlas', and correspondence re a version for IBM/360.

Research

D.573 1970-73

Correspondence about BOMM and BOOM.

D.574-D.576 Miscellaneous reports and work by Bullard on BOOM.

D.574 'Thoughts on BOOM', 15 July 1968.

'Decisions based on thoughts on BOOM', 23 July 1968.

D.575 'Note on the present state and prospects of BOOM on the CDC 7600 at Berkeley', with a trial printout and a circular letter from W.H. Munk on the BOOM project, February 1976.

D.576 Ms. narrative and printout, on 'Meta-statements in BOOM', n.d.

Research

D.577-D.585 CONTINENTAL DRIFT, c.1962-65, 1975

Bullard researched and published extensively on this and allied topics, but the surviving manuscript documentation is relatively scanty. D.577-D.580 relate to his collaborative paper with J.E. Everett and A.G. Smith 'The fit of the continents around the Atlantic' (Bibliog. 1965a); D.583-D.585 date from 1975 when he began a re-examination of the subject.

See also D.646.

D.577 Draft for 1965a paper, few pages only, some ms. annotations by Bullard, 1p. comments by A.G. Smith, and 4pp. 'data notes' on continental fit, by Smith.

D.578 Ms. notes, calculations and charts by Bullard.

D.579 Computer printouts of data for paper.

D.580 Correspondence (addressed to J.E. Everett), re statistical methods for solving problems of continental fit, 1962.

D.581 'A mechanism for diastrophism'

8pp. draft for a paper on orogeny by M.J.S. Dewar, dated 1 September 1947 and found with material.

D.582 Incomplete ms. for a paper on continental drift, sea floor spreading and plate tectonics, p.4, pp.37-54. n.d. but latest reference 1971.

There is a ms. note by Belinda Bullard that the paper was 'found in cupboard at Madingley Rise [Cambridge] July'.

D.583 'Atlantic Fit'

Miscellaneous notes, charts, a few dated October 1975.

Research

D.584 Correspondence with colleagues, mainly sending information on Atlantic fit in response to Bullard's requests, June-July 1975.

D.585 Miscellaneous lists of maps, reports, etc. requested or ordered by Bullard for work.

Research

D.586-D.592a PALAEOMAGETISM, 1964-67

This is mainly concerned with the analysis of rock samples collected during expeditions in the Pacific Ocean organised by the Scripps Institution: to Easter Island and the Juan Fernandez Islands in July 1964 and 1966, and to Fiji and other Pacific Islands in July 1967.

Bullard wrote a collaborative paper on the subject with J. Booker and R.L. Gasty (Bibliog. 1967g).

For further correspondence about the expedition and research, see C.17, C.20.

D.586 Green notebook, with Bullard's name and addresses at La Jolla and Cambridge inside front cover, and labelled '6/64. Rocks. Easter Is. & Juan Fernandez'.

Includes list of sites of samples, diagrams, description of collection methods, analysis of magnetisation, etc., mainly but not all in Bullard's hand. Includes some later material, 1965, and a note of samples 'Sent to Blackett 8/4/65'. (P.M.S. Blackett, who was working on magnetic reversal at that time.)

D.587 Similar notebook, with Bullard's name and address and date, July 1967, inside front cover and labelled 'NOVA Leg 3 July 1967'.

Pages numbered 1-16, with several loose pages of maps and diagrams. Entries run 31 June-20 July 1967 and are described as 'Collection of oriented rock samples for palaeomagnetic and age determinations'. At rear of book, 1p. only account of expenditure. All in Bullard's hand.

D.588 Bullard's list of rocks collected on 1964 expedition.

Typescript 'Description of work on Easter Island' taken from Bullard's diary.

Maps and charts indicating sites of rock specimens taken.

Research

D.589 Bullard's notes and calculations.

4pp. sequence 'Track of R.V. Baird during 1st leg of Carousel' (code name for 1964 expedition).

Notes, drafts, charts, mainly on Alijos rocks.

Miscellaneous computer programs (using BOMM) for processing data on rocks, July 1964.

2pp. shorter notes on 'Easter Is.'.

D.590 Charts and diagrams, probably for a publication, all drawn or annotated by Bullard.

D.591 Charts of rock samples, by Bullard and others.

D.592 Correspondence and reports from colleagues.

'Work report on measurements of the magnetic properties of basalts from Easter and Juan Fernandez Islands', by A.I. Rees, February 1965.

J.A. Miller, August 1965.

J. Booker, September 1965

'Preliminary petrological report on rocks from Easter Island and the Juan Fernandez Islands', by F.J. Fitch, n.d.

D.592a Printout with ms. note 'Easter Island, magnetisation of rocks', July 1966.

In original folder, inscribed 'Pacific Track and Easter Islands 1964'.

Research

D.593-D.609 ELECTRICAL CONDUCTIVITY OF OCEANS, 1965-71

The material was received as the contents of a filing-drawer divider labelled 'Induction in Ocean'.

Bullard began work on the topic in 1965 (see D.593) but most of the dated notes and drafts are 1967, 1968. They include some computer programs and printouts, and a little material from R.L. Parker and other colleagues. Bullard published a collaborative paper with Parker, 'Electromagnetic induction in the oceans' (Bibliog. 1970a). See G.54.

D.593 Correspondence with R.A. Cox, in which Bullard explains the purpose of the research 'to calculate the effect of the oceans on magnetic variations' and requests information, December 1965.

D.594 Notes, data, programs, etc. on temperatures and salinity in Indian and Pacific Oceans, various dates, January, March, May 1967.

D.595 Miscellaneous notes, research ideas, diagram by Bullard, related to 1967 work.

D.596 Correspondence from colleague and collaborator, with data.

Includes research notes from R.L. Parker, 1967-68.

D.597 Miscellaneous shorter data, annotated bibliography, 1967 and 1968.

D.598-D.609 Drafts and notes by Bullard.

D.598 'The electrical conductivity of the oceans'

Typescript with ms. corrections (photocopy), dated 'August 1967', with a ms. note 'This note is intended as a summary and will not be published'.

Research

D.599	Extensive draft, paginated 1-74 with several intercalated pages, headed 'Induction in a sheet'.
D.600	'Induction in spherical shell', pp.1-10.
D.601	'Induction by motion in a disc', pp.1-8.
D.602	'Induction in a strip conductor', 2pp. (photocopy).
D.603	'Induction in a half space', pp.1-26.
D.604	'The general problem', 1p.
D.605	pp.15, 16 only of a sequence.
D.606	'Induction in ocean for short periods', 4pp., dated July 1971.
D.607	Photocopy of part of a paper on induction, heavily annotated and revised by Bullard.
D.608, D.609	Unpaginated notes, drafts, diagrams by Bullard relating to conductivity research, 1967-68. 2 folders.

Research

D.610-D.612 MAGNETIC VARIATIONS, 1967-69

D.610, D.611 'Removal of Trend'

Contents of a filing-drawer divider so labelled. Bullard published a paper 'The removal of trend from magnetic surveys' (Bibliog. 1967b), though some of the material here is later.

D.610 Ms. drafts by Bullard, 19pp., 2pp., 2 pp.

Diagrams (perhaps for 1967 paper).

D.611 Letter and data from L.R. Alldredge, with Bullard's notes and data on the subject, February 1967.

Includes letter to Members of Working Group on 'Analysis of the Geomagnetic Field' (Bullard was a member), November 1967.

D.612 'Magnetic Variations'

Contents of a filing-drawer divider so labelled.

Ms. notes and diagrams, charts (various dates, December 1968, January 1969), brief correspondence.

Research

D.613-D.643 ENERGY SOURCES / NUCLEAR WASTE, 1976-80

Most of this work consists of drafts and background material for Bullard's contribution to collaborative publications of JPL where he was a consultant (Bibliog. 1977c, 1977d).

Of interest are the fragmentary drafts for an uncompleted book on the subject on which Bullard was engaged at the very end of his life (D.626-D.629).

The work on abiogenic methane at D.640-D.643 represents Bullard's contribution to the discussion of T. Gold's hypothesis on the viability of abiogenic methane as a fuel source, and was undertaken at the request of the Director of the Office of Science and Technology Policy.

For contracts and terms of Bullard's consultancy at JPL, and other related material, see E.99-E.113.

The material is presented as follows:

D.613-D.625 Drafts for publications and papers

D.626-D.636 Ms. drafts, notes and calculations

D.637-D.639 Background statistics and information assembled by Bullard

D.640-D.643 Abiogenic Methane

Research

D.613-D.625 Drafts for publications and papers

D.613 'Notes on the problems of waste disposal from light water reactors'

9pp. typescript, 4 January 1976.

D.614 'The central problem in waste disposal, notes by Edward Bullard'

5pp. typescript, n.d.

D.615 'Effect of Radioactive Heat on Seabed Disposal of Nuclear Waste'

3pp. typescript research proposal by Bullard 'to examine the stability of clay containing buried heat sources', n.d.

D.616 'Waste disposal - a brief review, by Edward Bullard'

Versions of a paper, all with variants, dated 17 October 1976, 21 October 1976, and a second amended copy with 1 page dated 23 March 1977.

D.617 'Summary'

4pp. typescript and ms. (photocopy), for collaborative publication, probably Bibliog. 1977c.

D.618 'Appendix A. Energy'

9pp. typescript unsigned but by Bullard, n.d.

D.619 'Appendix B. Units of energy'

6pp. typescript and ms. n.d.

D.620 'Appendix. Effect of Plutonium Recycle Options on High-Level Nuclear Waste Management'

4pp. typescript, no author or date.

Research

D.621, D.622 'Origin, nature and disposal of high level waste'

Paper written as 'Appendix A', described by Bullard as 'a background paper [which] does not go into the detail of the main report', n.d., but 1977.

D.621 Ms. and heavily-corrected typescript draft (photocopy)

D.622 Typescript version of above, 36pp.

D.623 'High-level Waste'

25pp. typescript + 7pp. figures, with a few ms. corrections dated 2 June 1977.

(Uses some similar material to D.622.)

D.624 'Notes on Waste Disposal'

4pp. typescript with a ms. note 'For Adm. Long's daughter', dated 8 December 1978.

Enclosed here is a copy of a letter from W.H. Munk forwarding the material.

D.625 Letter to Bullard (JPL Interoffice memo.) from J. Klimberg commenting on Bullard's seminar at La Jolla on 'Lasting Engineered Structures for Disposal', February 1977.

Research

D.626-D.635 Ms. drafts, notes and calculations

D.626-D.629 Drafts for an uncompleted book on energy, with special reference to nuclear power. The work is all in Bullard's hand, very heavily revised and corrected, sometimes fragmentary and not easily attributable.

D.626 'Preface', 10pp.

Here Bullard outlines the scope of the book as follows:

Chapter 1	'an outline of the world's energy needs and resources and of the reasons for considering nuclear energy as a major source'
Chapter 2	'the nuclear fuel cycle of the Light Water Reactor'
Chapter 3	'the nature of the waste and its radioactivity'
Chapter 4	(omitted)
Chapter 5	'biological effects of radioactivity'
Chapter 6	'options for disposal'
Chapter 7	'effect of alternative fuel cycles on waste disposal'
Chapter 8	'possibilities of the diversion of materials from the fuel cycle either by non-nuclear states or by terrorists'
Chapter 9	summary and conclusions

D.627 'Chapter 1 'How much will be enough'

18pp. + 1p. There is a ms. note at the head 'book in progress 1980'.

D.628 Miscellaneous drafts for chapter 5 on biological effects of radiation, pp.1-4, 8-14, 9-13.

Research

D.629 Shorter paginated drafts, pp.5-7, 6-8, 17-25 (perhaps for Chapter 1).

D.630 'The generation of radioactivity by a reactor'

4pp. ms. note 'to prove a theorem which seems not to be widely known'.

D.631 Shorter paginated sequences of notes and calculations.

D.632-D.636 Shorter notes, statistics, references, etc., a few with dates, 1976-79.

5 folders.

D.637-D.639 Background information and statistics

Miscellaneous material assembled by Bullard on nuclear waste and energy sources in America, a few with ms. annotations.

3 folders.

D.640-D.643 Abiogenic Methane

Correspondence and papers examining the proposal by T. Gold that 'methane ... and other hydrocarbons may have been significant components of primordial Earth'. Bullard was asked for his views and comments, which he conveyed in a paper (D.641) and which were considered in preparing its report to the Office of Science and Technology Policy by the ad hoc Committee on Abiogenic Methane of the National Academy of Sciences.

D.640 Correspondence, July-November 1979.

Includes invitation to forward comments, exchanges with colleagues.

Also included is a copy of a letter by T. Gold on methane deposits, February 1979, sent to Bullard for information.

Research

D.641 'Abiogenic Methane'

Bullard's report on the subject, 9pp. typescript, dated 10 September 1979.

With covering letter, and a ms. note of others who received copies.

D.642 'Abiogenic Methane: scientific and practical considerations of its potential as an energy source'

Report of ad hoc Committee, with background papers, 8 October 1979.

D.643 'Alternative Gas Workshop'

Papers and correspondence re meeting at Los Alamos Scientific Laboratory, September 1979, which Bullard attended. Includes programme, list of participants, brief correspondence, and a few brief notes by Bullard.

D.644-D.651 MISCELLANEOUS

D.644 Maps for gravity survey in Britain.

D.645 Maps of boreholes, for work on heat flow in South Africa, 1937-39. See D.359-D.371.

D.646 Maps and drawings on continental fit, c.1964. See D.577-D.585.

D.647 Ms. notes and drawings. Includes original figure for an early pendulum paper.

D.648 Shorter ms. notes, on spherical harmonics and other topics (from later part of Bullard's career).

Research

D.649 Ms. diagrams and charts by Bullard.

D.650 Data and diagrams by others.

D.651 Typescript material, with ms. annotations by Bullard, on 'The Cambridge Supermap Programs'.

SECTION E COMMITTEES AND CONSULTANCIES E.1 - E.231

INTRODUCTION TO SECTION E

The material is presented in alphabetical sequence and covers both government and private commercial work.

Bullard undertook consultancy and committee work for a number of government departments. His connection with the Admiralty dates from the mid-1930s when the Navy cooperated with the Cambridge Department of Geodesy and Geophysics in marine geophysical research and Bullard joined the Admiralty Research Department during the Second World War. There is virtually no record of the wartime work in the collection. * After the war he was a consultant and served on government committees on atomic energy, atomic weapons, nuclear disarmament and maritime defence and served as the chairman of Lord Hailsham's Space Steering Committee. Bullard also had a number of important consultancies with industrial concerns. The most fully documented are those with Shell and IBM UK where he was a director for ten years.

* For unpublished wartime papers, see G.19.

SOME OF THE MATERIAL IN THIS SECTION MAY BE SUBJECT TO RESTRICTION

Committees and consultancies

LIST OF CONTENTS

Committees and consultancies

E.1-E.8 ADMIRALTY, 1936, 1938-39, 1941, 1944, 1946, 1953, 1959

E.1 1936

Letter from Department of Scientific Research and Experiment to G.P. Lenox-Conyngham re data on ships' movements.

1938-39

Correspondence and papers re seismological experiments carried out from H.M.S. Jason under the direction of Bullard, and gravity work carried out by the submarine H.M.S. Narwhal under the direction of B.C. Browne.

See also D.342-D.351.

E.2 1939

Correspondence re Bullard's wartime appointment as Temporary Senior Experimental Officer in the Admiralty Scientific and Technical Pools. He was assigned for duty in the first instance to the A/S Establishment, H.M.S. Osprey, Portland.

E.3 1941

Manuscript draft, with much crossing-out, corrections and interlineation, of a letter to (?R.H.)Fowler, dated at Edinburgh 9 June 1941, with Bullard's criticism of the Admiralty Experimental Establishments, particularly H.M.S. Osprey.

E.4 1944

Copy of memorandum by A.C. Hardy on proposed new methods of making hydrological surveys of wide areas from commercial ships down to depths of 200 metres, with covering letter from the Hydrographer of the Navy.

E.5 1946

Correspondence re book by R.A. Lochner which dealt with wartime Admiralty research.

Committees and consultancies

E.6 1946

Correspondence re request from Italy for the retention of a submarine for gravity work. Under the terms of peace, all Italian submarines were to be destroyed.

E.7 1946

Seventh report of Admiralty Computing Service, with carbon of Bullard's letter acknowledging its receipt.

E.8 1953, 1959

Brief correspondence.

E.9-E.13 ATOMIC ENERGY RESEARCH ESTABLISHMENT (AERE) HARWELL, 1947-48, 1958-59, 1968

E.9 1947-48

Brief correspondence with J.D. Cockcroft.

Brief correspondence re Bullard's appointment as Consultant to the Department of Atomic Energy, Ministry of Supply, with effect from 1 March 1948.

1p. ms. notes headed 'Times of Atomic Bomb Explosions', and 1p. ms. notes headed 'Distance from Kew'.

8pp. typescript paper by Bullard on 'The Detection of the Explosion of Atomic Bombs'.

E.10 1958-59

Agendas, notices of meetings and committee papers of the CTR (Controlled Thermonuclear Reactions) Advisory Committee.

Bullard was a member of the reconstituted committee which met for the first time on 18 December 1958.

Committees and consultancies

E.11 1958, 1968

Brief correspondence only.

The 1968 correspondence relates to the 1967 Harwell Conference on Technology of Sea and Sea-Bed.

E.12 1964

Extract from a draft, dated 18 September 1964, of the Users' Manual of the National Institute for Research in Nuclear Science, Atlas Computer Laboratory.

The extracted pages are taken from Part II entitled 'Putting a Job on the Machine', and were filed by Bullard with AERE Harwell.

E.13 Culham Laboratory 1961, 1963, 1969

Brief correspondence re invitation for Bullard to speak at a colloquium (1961) and proposed IPPS Conference on Computational Physics (1969) and two internal papers on the dynamo problem of the earth's core (1963).

Bullard filed this Culham material under AERE Harwell.

E.14-E.22 ATOMIC WEAPONS RESEARCH ESTABLISHMENT (AWRE) ALDERMASTON, 1960-68, 1972

E.14 Correspondence re Bullard's appointment as Consultant to AWRE (1960), consultancy fees (1965, 1968).

E.15, E.16 Correspondence with AWRE personnel. Various dates, 1961-66. In alphabetical order.

Two folders.

Committees and consultancies

E.17 Background papers on seismic research, with particular reference to underground detection programmes, 1960.

E.18 Tagged folder entitled 'Review of Seismology II', Blacknest, May 1961.

E.19 Paper by H.I.S. Thirlaway (2pp.) entitled 'Summary of Observations from a Study of the Attached Records', Blacknest, 26 November 1963.

There are ten figures attached.

E.20 'IBM 7090 Installation. A brief guide for visitors', Aldermaston, November 1960.

11pp. booklet.

E.21 Reactor Group Headquarters, Risley, Warrington, 1962-63, 1966-68.

Correspondence and papers re computer applications, including references to the BOMM program.

Bullard's work was apparently transferred from the Aldermaston IBM to Risley and the Risley material was filed by Bullard with AWRE, Aldermaston.

E.22 United Kingdom Atomic Energy Authority, 1964, 1967, 1972.

Brief correspondence only, filed for convenience with AWRE, Aldermaston.

E.23 Not used.

Committees and consultancies

E.24 BRITISH PETROLEUM, 1944-45

Brief correspondence re consultancy.

E.25 BURMAH OIL COMPANY LIMITED 1945-46

Brief correspondence re consultancy, with three duplicated pages of 'Discussion of Dr. Bullard's Comments'.

E.26 CIVIL SERVICE COMMISSION 1945-47, 1977

Bullard accepted an invitation to join the panel of physicists to advise on recruitment for the Scientific Services of the Government.

Invitation to join panel, correspondence and papers re selection board meetings, promotions.

E.27-E.36 COMMITTEE ON COLONIAL GEOPHYSICAL SURVEYS 1944-47

E.27 Correspondence between Colonial Office and Sir Gerald Lenox-Conyngham re formation of a Committee to advise on the geological needs of the Colonies, 1944.

Lenox-Conyngham felt unable to serve himself and strongly recommended Bullard for the Committee.

Committees and consultancies

E.28 Committee papers:

'Summary of Publications issued by Colonial Geological Surveys, etc.', with covering letter dated 17 April 1944.

'Expenditure before the War', n.d.

E.29 Report of the Committee on Colonial Geology, July 1944, with brief correspondence re report, 1947.

E.30 Brief correspondence re colonial geological surveys, 1945, 1947.

E.31-E.36 British Commonwealth Survey Officers' Conference, 1947

E.31 Brief correspondence re organisation of conference, with provisional agenda, amendment to provisional programme and list of those attending Conference.

E.32-E.36 Conference papers arranged alphabetically by author:

E.32 B - E

E.33 G

E.34 H

E.35 L - N

E.36 P - W

Committees and consultancies

E.37-E.55 FOREIGN OFFICE, 1946-48, 1959, 1965-68, 1971-74

This material is arranged alphabetically by commission, department, panel, etc.

E.37 Brief correspondence, 1959, 1973.

E.38-E.48 Arms Control and Disarmament Panel, 1965-68, 1971-74

For earlier Foreign Office correspondence re disarmament see E.124.

E.38 'Report of the Working Group on Proliferation of the Panel of Advisers to the Minister of State for Disarmament', April 1965.

Bullard was the principal author of this report.

E.39 Report of the Disarmament Panel Sub-Group on China and the Bomb. n.d. (1965 or later).

E.40 Correspondence, 1966, re disarmament questions generally, meeting of advisory panel.

E.41 Miscellaneous papers relating to disarmament questions; photocopy of letter to The Times, 18 August 1966, headed 'Initiative to Halt Arms Race' (not from Bullard).

E.42 Further miscellaneous papers re disarmament questions.

E.43 Correspondence and committee papers, 1967.

E.44 Correspondence and committee papers, 1968.

E.45 Correspondence and committee papers, 1971.

E.46 Correspondence and committee papers, 1972.

Committees and consultancies

E.47 Correspondence and committee papers, 1973.

E.48 Correspondence and committee papers, 1974.

E.49-E.53 Control Commission for Germany, Research Branch, 1946-48

E.49 1946

Correspondence re visit to Germany by Bullard to advise on Geophysics at the Institute at Göttingen and in connection with the Geologisches Landesamt; also preliminary enquiry as to whether Bullard would serve on a Physics Panel to advise on scientific matters in Germany and letter from N.F. Mott re possible meeting of Society for Visiting Scientists to discuss science in Germany.

E.50, E.51 1947

E.50 Correspondence, April-September, re German scientific matters, including letter appointing Bullard consultant to research branch of control commission.

E.51 Correspondence, October-November, re German scientific matters.

E.52 1948

Correspondence re German scientific matters including correspondence about the career plans of Julius Bartels.

E.53 Miscellaneous papers filed by Bullard under Control Commission:

British Intelligence Objective Sub-committee report on German academic geology.

International Geological Congress. Section 4 'The Geological Results of Applied Geophysics'. A Geophysical Compilation of North West Europe.

Allied Control Authority Control Council Law no.25. Control of Scientific Research.

Committees and consultancies

E.54 Marine and Transport Department, 1973

Brief correspondence re foreign research cruises in UK waters.

E.55 Overseas Development Administration (later Ministry of Overseas Development), 1973, 1975

Brief correspondence only.

E.56 GOVERNMENT COMMUNICATIONS HEADQUARTERS, CHELTENHAM, 1956

1 letter only.

Committees and consultancies

E.57-E.98 IBM UK, 1957, 1962-77, 1979

This material records Bullard's long association with IBM both as a user of the computer firm's data processing facilities and, for the period 1965-75, as a director of IBM UK. The very extensive correspondence relates to board meetings, fees and expenses, technical questions of computer performance, contacts made by Bullard for IBM in the universities, industry and government departments, and symposia, lectures, and other educational, scientific, cultural and social events organised or sponsored by IBM. There is also correspondence re a substantial gift from IBM to the University of Cambridge (E.83, E.84). For lectures given by Bullard for IBM see G.152, G.163.

E.57 1957

Letters of thanks for Bullard's address at opening ceremony of IBM's data processing centre.

E.58 1962

Brief correspondence re applications for computer time under IBM's Endowed Research Time Scheme.

E.59 1963-65

Correspondence re Project Magnet data with the Hydrographer of the Navy, the Royal Greenwich Observatory and IBM.

E.60 July-August 1964

Correspondence re use of computer time under Endowed Research Time Scheme. There are references to Project Magnet and BOMM.

See also D.568.

E.61 November-December 1964

Includes Bullard's letter accepting invitation to join the Board of IBM UK.

Committees and consultancies

E.62 1964-66

Correspondence re reprinting by IBM of Bullard's article 'The Language of Machines', which first appeared in Endeavour, September 1964 (Bibliog. 1964a, 1965f).

See also G.45.

E.63 January 1965

E.64 February 1965

Includes IBM memorandum on the British computer industry and copies of letters from IBM to the Director of the Electronic Engineering Association, with comments on the EEA's paper 'Electronics and the National Economy'.

E.65 March 1965 (1)

Includes copy of original draft of the EEA's paper on 'Electronics and the National Economy', with ms. comments, underscorings, etc., sent to Bullard by IBM.

E.66 March 1965 (2)

Includes copy of IBM memorandum of meeting, 23 March, between T.C. Hudson and B.J.A. Hargreaves of IBM UK with Frank Cousins, Minister of Technology, and copy of letter from Hudson to Cousins, 24 March, setting out the ways in which IBM UK might be of use to Cousins's Ministry.

E.67 April 1965

E.68 May-August 1965

E.69 September 1965

Includes IBM memorandum on computing equipment for hydrographic research vessels, based on discussions with Bullard and M.N. Hill.

Committees and consultancies

E.70 October-November 1965

E.71 December 1965

E.72 January-March 1966

Includes IBM memorandum re tender for computer system at R.A.E. Farnborough.

E.73 April-December 1966

Includes correspondence re computer system intended for proposed Institute of Astronomy in Cambridge and diagrams of layout of computer system for Cambridge University Institute of Theoretical Physics.

E.74 January-April 1967

E.75 May 1967

Includes internal memorandum on visit by Bullard and IBM personnel to BAC (Filton) re BAC's purchase of an IBM computer.

E.76 June-July 1967

E.77 September-October 1967

E.78 November-December 1967

Includes internal memorandum: 'Notes on an interview with Sir Edward Bullard at the Department of Geodesy and Geophysics, Cambridge', 8 November. Bullard was interviewed by IBM's Academic Relations Manager and commented, amongst other things, on IBM's image in the university.

Committees and consultancies

E.79 January-February 1968

Includes draft letter from IBM to B.H. Flowers re new IBM computer.

E.80 March-April 1968

E.81 May-December 1968

E.82 January 1969

E.83, E.84 1969-72

Correspondence re gift to the University of Cambridge for seven years.

E.83 1969-70

E.84 1971-72

E.85 January-February 1970

E.86 March 1970

E.87 April-October 1970

E.88 1971

Includes correspondence and internal memoranda re visit to NPL by Bullard and IBM personnel.

E.89 April-June 1972

Includes memorandum re meeting between H. Bondi, and Bullard and IBM personnel, to discuss MOD and Atlas Computing Laboratory.

Committees and consultancies

E.90	August-December 1972
E.91	January-June 1973
E.92	July-December 1973
E.93	January-March 1974
E.94	April-June 1974
E.95	July-September 1974
E.96	October-December 1974
E.97	1975 Includes minute of Bullard's resignation from the Board which took effect from 31 March.
E.98	1976-77, 1979 Brief correspondence only.

Committees and consultancies

E.99-E.113 JET PROPULSION LABORATORY, CALIFORNIA INSTITUTE OF TECHNOLOGY (JPL), 1976-80

Bullard was invited to take on a consultancy with JPL initially for one year, with particular reference to their nuclear waste programme. It was also hoped that he would take an interest in other geophysical activity at JPL, and make a private report to the director on the state of science there.

For research notes and publications for JPL, see D.613-D.643 passim.

For lecture given at the JPL, see G.172.

E.99 Correspondence re consultancy agreements, 1976-79.

E.100-E.106 General correspondence. In chronological order.

E.100 August, October-November 1976

E.101 1977

Includes letters written during a visit to Australia which touch on the melting of icebergs to get fresh water from them and Australian policy on uranium mining and export.

E.102 January-February 1978

Includes interoffice memos. on nuclear waste management and ms. drafts of two short papers by Bullard on proposals for the disposal of nuclear waste.

E.103 March 1978

Includes notes by Bullard on energy use and supply and draft paper by Lester Lees on scenarios for future primary energy demand and supply.

Committees and consultancies

E.104 April-June 1978

Includes Bullard's ms. comments on JPL's interim report to NASA on nuclear waste disposal and on the long range environmental constraints proposal, and the interoffice memo. which announced that the nuclear waste disposal project was to be wound up.

E.105 1978-79

E.106 1980-81

1981 correspondence is a letter setting out Bullard's contributions to JPL projects on radioactive waste disposal.

E.107 'Applications of JPL Technology', 11 October 1979.

13pp. paper by Bullard discussing how the new technologies developed in JPL's work for NASA could be applied to meeting more mundane needs.

E.108-E.112 Advanced unmanned underwater systems and instrumentation workshop, Pasadena, 30 October-1 November 1979.

Bullard was a member of the waste disposal and monitoring panel.

E.108 Programme, list of participants and brief correspondence.

E.109 Papers relating to waste disposal and monitoring panel, including summaries of sessions.

E.110 Summaries of sessions of water column and Benthic Research panel.

E.111 Summaries of sessions of Geological and Geophysical Surveying and Mapping and Ocean Mineral Resources and Production panels.

E.112 'Miscellaneous notes concerning discussions by panel members on the panel originally entitled Sea Floor Engineering and later called the Panel on Ocean Engineering on the Sea Floor.' 57pp.

Committees and consultancies

E.113 Miscellaneous material found with JPL papers.

E.114 METEOROLOGICAL OFFICE, 1960-62, 1975

Brief correspondence re research fellowships and Meteorological Office personnel.

E.115-E.143 MINISTRY OF DEFENCE, 1956-78

E.115-E.135 General Correspondence, 1956-68

Bullard served on a number of committees and working parties and corresponded about matters of mutual interest, e.g. disarmament, Russian science and scientists.

E.115 1956

Includes suggestion that Bullard should spend four or five months in Moscow in connection with the possible appointment of a Scientific Attaché there.

E.116 1957

E.117 January-June 1958

Includes list of 16 British atomic tests, 1952-57, drawn from publicly available sources.

E.118 July-November 1958

Includes duplicated material re conference to study methods of detecting violations of a possible agreement on suspension of nuclear tests, Geneva, July-August.

Committees and consultancies

E.119 January-June, December 1959

Includes letter from Bullard re membership of the Pugwash Committee.

E.120 1960

Includes material prepared from publicly available sources on the Soviet scientific township, Novosibirsk, and ms. note by Bullard entitled 'Large Earthquakes in USA and China'.

E.121 January-June 1961

Includes correspondence re meetings of the British Nuclear Deterrent Technical Sub-Committee.

E.122 July-December 1961

Includes letter accepting invitation to be a member of a panel on Technical Aspects of Disarmament.

E.123 January-May 1962

Includes duplicated summary of Soviet statements on matters affecting disarmament and nuclear testing, 8 March.

E.124 July-December 1962

Includes correspondence with Foreign Office re disarmament questions.

E.125 January-March 1963

E.126 April-June 1963

Includes correspondence re invitation to join a naval enquiry, and visit to USA in connection with enquiry.

E.127 July-September 1963

Committees and consultancies

E.128 October-December 1963

Includes draft article by Bullard entitled 'The Test Ban - What Next'. Not published.

8pp. typescript with ms. corrections.

E.129 January-June 1964

E.130 August, October-December 1964

E.131 1965

Includes material and correspondence re the Hornig/Zuckerman talks.

E.132 January-March 1966

Includes correspondence re request from C. Pekeris in Israel for the loan of equipment which would enable him to select a site for a 'modern seismic station'.

E.133 September-October 1967

E.134 May-June 1968

E.135 October-December 1968

Correspondence re loss at sea of oceanographic equipment in buoys, with MoD, Ministry of Agriculture, Fisheries and Food, and Royal Society.

Committees and consultancies

E.136-E.141 Defence Scientific Advisory Council (DSAC), 1969-75

In 1969 a new Defence Scientific Advisory Council was constituted to provide the Secretary of State for Defence with independent advice on research and development activities within the Ministry of Defence. Bullard accepted an invitation to serve on the Undersea Warfare Board. In 1972 the Undersea Warfare Board was merged with the Ships Board to form the Maritime Warfare Advisory Board and Bullard agreed to serve on the new board. Also in 1972 he accepted an invitation to serve on a working party on Maritime Air. He resigned from the Maritime Warfare Advisory Board at the end of 1974 because he was going to spend most of 1975 in the USA.

Correspondence and committee papers.

E.136	1969 Includes invitation to serve on DSAC's Undersea Warfare Board, Bullard's letter of acceptance, and official note describing DSAC's terms of reference and machinery.
E.137	1970
E.138	1971
E.139	1972
E.140	1973
E.141	1974-75

Committees and consultancies

E.142, E.143 General Correspondence, 1973-76, 1978

E.142 1973-74

Includes correspondence re project for a satellite laser tracker.

E.143 1975-76, 1978

E.144 MINISTRY OF LABOUR AND NATIONAL SERVICE, 1944-46

Bullard served on the reconstituted Scientific Research Advisory Committee of the Technical and Scientific Register.

Correspondence and committee papers.

See also A.55.

Committees and consultancies

E.145-E.161 MINISTRY OF SCIENCE, 1960-71

Ministry of Science was the designation on Bullard's original folders which more properly should have been Office of the Minister of Science, later Department of Education and Science.

E.145-E.157 UK Space Research Steering Group, 1960-63

Bullard was chairman of the group. The correspondence and committee papers relate to the funding of space research, international cooperation, the Blue Streak rocket and satellite and telescope projects. They are presented in a chronological sequence.

E.145 February 1960

Includes copy of letter from Woodrow Wyatt MP to Harold Macmillan enclosing a memorandum from the British Interplanetary Society on a space programme for the UK, a 5pp. typescript commentary on the memorandum and a note on the status of the society (2pp.).

E.146 March-April 1960

Includes 4pp. typescript draft entitled 'Scientific Benefits from Satellites capable of being launched by Blue Streak', with ms. note by Bullard 'This is the paper for Hailsham that I dictated over phone 26/4/60'.

E.147 May 1960

Includes 3pp. typescript note by A.W. Lines on the 'Technological Stimulus of Satellite Research'.

E.148 June 1960

Committees and consultancies

E.149 July-September 1960

E.150 November-December 1960

Includes photocopy of paper from NASA giving their views on an agenda for the proposed UN Outer Space Conference planned for 1961.

E.151 January-February 1961

Includes material re visit of Japanese mission on space science.

E.152 March, May 1961

E.153 June-July 1961

Includes correspondence and papers re Project West Ford, 3pp. typescript paper by D.W. Parkin on the collection of cosmic dust from outer space using recoverable earth satellites, and 2pp. typescript notes prepared for Lord Hailsham, setting out Bullard's doubts about the British space programme.

E.154 August-December 1961

E.155 January-February 1962

E.156 April-June, November 1962

E.157 January-May, September 1963

Includes report of working party under chairmanship of J.A. Ratcliffe on the effects of high-level nuclear explosions on scientific experiments.

Committees and consultancies

E.158-E.161 General Correspondence, 1962-67, 1969-71

A chronological sequence of correspondence on matters other than space research.

E.158 1962-63

Includes paper by Bullard on 'The Financing of Research in Universities'. (2pp. duplicated typescript), prepared to be sent to Trend Committee.

E.159 1964

Includes paper by Bullard on 'The Earth Sciences and the Trend Report', prepared at the request of the Office of the Minister for Science (9pp. duplicated typescript with ms. corrections, dated 7 February 1964) and correspondence and papers re setting up of the Natural Environment Research Council and the funding of the National Institute of Oceanography.

For NERC see F.51-F.74

For NIO see F.36-F.38

E.160 1965-67

Correspondence re NERC, NATO Advanced Study Institute and Russian scientific exchange visit.

E.161 1969-71

Correspondence and reports re NATO Advanced Study Institute.

MINISTRY OF OVERSEAS DEVELOPMENT - see under FOREIGN OFFICE

Committees and consultancies

E.162-E.176 MINISTRY OF SUPPLY (later MINISTRY OF AVIATION), 1946, 1956-61

Most of the material (E.163-E.175) covers the period of Bullard's service as Chairman of the US/UK Advisory Committee on Medium Range Ballistic Missiles. He resigned in 1959 when he agreed to take on the Chairmanship of the Minister of Science's Space Steering Committee and the Ballistic Committee itself was then wound up.

The material which is arranged in a dated chronological order relates to committee meetings, visits to the USA, expenses, and other Ministry of Supply affairs on which Bullard was consulted.

E.162 1946

Brief correspondence re a problem of explosives.

E.163 January-February 1956

E.164 April-July 1956

Includes invitation for Bullard to investigate the work in the Ministry of Supply on airborne magnetometers and to 'prepare a report on how it is related to the existing foreign equipments'.

E.165 June 1956

Progress reports on three-component magnetometer, 1953-56, and notes on development of airborne magnetometers, sent to Bullard, with covering letter, 20 June.

E.166 August-October 1956

E.167 November-December 1956

E.168 January-February 1957

Committees and consultancies

E.169 March-May 1957

Includes Bullard's report on airborne magnetometer (5pp. typescript with ms. corrections).

See also D.428

E.170 July-September 1957

E.171 October-December 1957

Includes correspondence re visit to USA in connection with Ministry of Supply committee work.

E.172 January-May 1958

E.173 July-December 1958

E.174 January-June 1959

E.175 July-October 1959

Includes carbon copy of Bullard's letter of resignation from Ballistic Missiles Committee.

E.175A Notebook with record of classified documents sent to Bullard 1954-57, probably in connection with Ballistic Missile Committee; loose in notebook is carbon of letter from M.N. Hill, 5 May 1960, returning other documents to Admiralty.

E.176 1960-61

Committees and consultancies

E.177-E.184 OSCAR WEISS, CONSULTING GEOPHYSICST (JOHANNESBURG), 1946-48

Bullard agreed to act as scientific adviser to Oscar Weiss in August 1946. There is some correspondence re scientific problems but the greater part of the papers relates to the supply of scientific equipment and comprises correspondence with Weiss, suppliers of scientific instruments and the Ministry of Supply (re disposal of surplus stocks). The material is presented in a chronological sequence.

E.177 August-December 1946

E.178 January-March 1947

Includes two photographs of vehicles used by Oscar Weiss in geophysical surveys.

E.179 April 1947

E.180 May 1947

E.181 June 1947

E.182 July-August 1947

E.183 September-December 1947

E.184 January-March 1948

Committees and consultancies

E.185-E.187 PHYSICAL DYNAMICS INC./LA JOLLA INSTITUTE, 1976-79

In March 1976 Bullard entered into a consultancy agreement with Physical Dynamics Inc. In September of the same year the President of Physical Dynamics Inc., Adolf R. Hochstim, invited Bullard to become a consultant of the newly-founded La Jolla Institute, of which Hochstim was a Trustee and President/Treasurer. The La Jolla Institute described itself as a non-profit research institute for science and technology.

E.185 Correspondence re consultancy agreement with Physical Dynamics Inc., 1976.

E.186 Invitation to Bullard to become a consultant of the La Jolla Institute, 1976, and background material re the Institute.

E.187 General correspondence, 1977-78, including 4pp. letter from Bullard on the transmutation of fission products and brief correspondence re Topics in Non-Linear Dynamics to which Bullard had contributed.

Also included in this folder is 1p. ms. notes with diagram of disk dynamo, and photocopy of the same, with the results circled in red, found with the preceding material.

See also A.7, G.98, G.99.

E.188 RIO TINTO COMPANY LIMITED (later RIO TINTO-ZINC CORPORATION LIMITED), 1957, 1961, 1968

Brief correspondence re consultancy work, Bullard's letter of congratulations on the occasion of Val Duncan's knighthood (1968).

Committees and consultancies

E.189-E.229 SHELL OIL COMPANY, 1949, 1955-63

Bullard became a consultant of Shell from the beginning of 1956. There is an extensive correspondence re the technical problems upon which he was consulted and his visits to research laboratories in Holland and the United States. Bullard's advice was also sought on science education questions including the placing of Shell Commonwealth Scholars in British Universities, and in this connection will be found Bullard's comments on the Cavendish Laboratory and Nuclear Physics at Cambridge. Bullard interested himself in computer developments within the Shell organisation and corresponded on this subject with Lord Rothschild, a director, and Shell personnel. The correspondence is arranged in a chronological sequence. For papers written by Bullard for Shell, see E.214-E.226. For lecture given by Bullard for Shell, see G.145.

E.189 1949 (1 letter only)

E.190 August-December 1955

E.191 January-February 1956

E.192 March-April 1956

E.193 May-July 1956

Includes a 3pp. typescript note by Bullard on two papers by P. Leicester, another copy of which appears at E.214.

E.194 September-October 1956

E.195 November-December 1956

E.196 January-February 1957

Committees and consultancies

E.197 March 1957

E.198 April-June 1957

E.199 July-October 1957

Includes 6pp. typescript paper by Bullard on 'The Application of the Mass-Spectrometer to the Study of Sediments'.

E.200 March-May 1958

E.201 July-August 1958

E.202 September-October 1958

Includes 2pp. typescript, 'Notes on discussions on recovering a wire with Cable and Wireless Ltd. and with the Telegraph Construction and Maintenance Co. Ltd.'.

E.203 November-December 1958

Includes 1p. typescript note on an all metal high-vacuum valve.

E.204 January-April 1959

E.205 May-June 1959

E.206 July-November 1959

E.207 January-March 1960

E.208 April-July 1960

Committees and consultancies

E.209 September-December 1960

Includes internal memorandum, 'Excavated Hole Storage (Conch Contract). Notes on Discussions with Sir Edward Bullard at Cambridge, 19 October 1960'.

E.210 January-March 1961

E.211 April-June 1961

E.212 July, October-December 1961

E.213 1963

Brief correspondence re grants from Shell to University Research Departments.

E.214-E.222 Papers written by Bullard for Shell, arranged in chronological order.

E.214 'Notes on two papers by Mr. P. Leicester', June 1956.

3pp. typescript.

Leicester's papers had suggested a systematic procedure for assessing the prospects of discovering oil in an area.

E.215 'The downward projection of potential fields', February 1957.

5pp. typescript, with ms. additions and corrections.

E.216 'Operational Research in the Oil Industry', March 1957.

4pp. typescript.

E.217 'Geophysics - Oil Exploration', 2 April 1957.

Lecture given by Bullard at University College, London, as part of a short course for science teachers organised by Shell.

3pp. typescript.

Committees and consultancies

E.218 'The work of the Geophysical Analysis Group of the Massachusetts Institute of Technology', July 1957.

7pp., 13pp. appendix and 1p. references, typescript with ms. corrections.

E.219 'The Application of the Mass-Spectrometer to the Study of Sediments', October 1957.

6pp. typescript.

E.220 'The location of fires in oil sands', 1 November 1957.

4pp. typescript with a few ms. additions and corrections.

E.221 'Location of a position at sea', 11 September 1958.

3pp. typescript, figures, and ms. additions.

E.222 'The distant future of the oil industry', October 1960.

5pp. typescript with figures and tables of oil consumption.

E.223-E.226 Undated papers written by Bullard for Shell.

E.223 'The balance of short and long term research'

10pp. typescript. Second draft.

E.224, E.225 'Note on California Oilfields'

E.224 7pp. typescript with figures.

E.225 2pp. typescript preliminary notes on California oil fields, ms. drafts of figures for paper and notes and calculations used in the preparation of the paper.

Committees and consultancies

E.226 'The relation between the record given by the seismic method proposed by Hales and by an ordinary seismograph'.

6 ms. sheets.

E.227 'The interpretation of seismic data'.

3pp. typescript by B.C. Browne found with Bullard's Shell papers.

E.228 Miscellaneous papers relating to computer development at Shell, 1959-60.

E.229 Miscellaneous unidentified ms. notes found with Shell material.

E.230 SMIDTH, F.L. & COMPANY LIMITED, 1946

Brief correspondence and report on the probable effect of blasting by Cement Limited, Dublin.

E.231 WARBURG, S.G. & COMPANY LIMITED, 1957

Brief correspondence re appointment of a scientific consultant.

Bullard declined the position and suggested other suitable scientists.