# NORMAN LESLIE FALCON

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Elected F.R.S. 1960

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## INTRODUCTION

Norman Falcon was a man of intellect, integrity and reserve. His skill, at times almost intuitive, in his chosen profession of petroleum geology was greatly admired and his judgement greatly respected by both colleagues and contemporaries alike. He had an understanding of his subject that reached out beyond the given wisdom of the day, which in turn could lead him to innovation and boldness in his self-confident application of his science, qualities wanting in workers of lesser calibre. His paramount interest was in the practical application of science, yet he always held a strong interest in and gladly supported the research of others. His work therefore was characterized by the application and use of his expertise and by giving direction to and supervising others, rather than by the pursuit of research into new realms of geology.

His whole career was spent in the employ of The British Petroleum Company and its predecessors, and it is inevitable that his successful geological career was inextricably interwoven with the affairs of the company. The major roles that he played reflect the history of oil exploration and undoubtedly he helped shape the company's history. BP did not and does not exist in industrial isolation, but as part of an enormous global industry. Thus it can truly be said that Norman acted on a world stage and his career helped make, and reflected the fortunes of, that worldwide industry.

N. L. Falcon

## Ancestry, marriage and family

Norman Leslie Falcon was born on 29 May 1904 at Braunton, North Devon, the younger son of Thomas Adolphus Falcon, M.A. (Cantab.), R.B.A., and Julie Alice Falcon (née Schwabe). His younger sister, Elizabeth, survives him. He was directly descended from yeoman farming stock and the ancestral Cumbrian farm remains in the family. His father was a landscape painter and silversmith and his mother an accomplished pianist. Together the parents provided a strong artistic background to family life.

On 27 January 1938 Norman married Dorothy Muriel Freeman, younger daughter of F.G. Freeman of H.M. Consular Service. Dorothy survives Norman, as do their three children, John Anthony, born in 1939, Michael Geoffrey, born in 1941, and Rosemary Sarah, born in 1945. There are four surviving grandchildren. Both sons were educated at Tonbridge School and Trinity College, Cambridge, and both followed scientific careers. John became a chemical engineer and Michael an ophthalmic surgeon. Sarah, educated at Benenden School, is married and has three children, all of whom share their great-grandparents' artistic interests.

## Education

Throughout boyhood Norman was strongly influenced by his father and together they enjoyed the countryside and open-air pursuits. After private school, he was educated from 1914 to 1923 at Exeter School, eventually becoming headboy. He showed great enthusiasm on the sports field, playing for the school in most field games. His studies were greatly influenced by Mr J.N. Bilsborough, B.A., who first aroused Norman's interest in geology.

He was never aware of any particular experience fostering an interest in the science but undoubtedly his whole boyhood way of life led him to such an interest. He once recalled that walking home from church after singing 'Rock of Ages', he stuck his knife to the hilt into a block of rock in a drystone wall and thought 'Well, that isn't all that it's made out to be.'

The death of his older brother and the development of a stammer from the age of seven marred an otherwise happy boyhood. His impediment gave him an abiding dislike of public speaking and inhibited his acceptance of public office. Later in life it did not prevent him from taking a full part in the professional and social world of a petroleum geologist.

Like his father, Norman went up to Trinity College, Cambridge, in 1923. He obtained First Class Honours in Geology to complete his B.A. Cantab. in 1927, and later his MA, having won a Senior Exhibition in 1926. Many of his contemporaries at Cambridge became academics and the friendships made then became of great importance later. An academic career was not one that Norman wished to pursue. He recognized that he was most interested in the application of geology rather than in research. He was also concerned about problems possibly arising from his speech impediment.

At Cambridge his mentors were Professor J.E. Marr, W.B.R. King and his supervisor, T.C. Nicholas. His first excursions abroad were climbing expeditions with L.R. Wager, F.R.S., in the French Alps. It was Professor Marr who encouraged him to join the Anglo-Persian Oil Company. W.B.R.King, F.R.S, lectured in geology and, importantly for Norman, conducted field work in Arran, the Pennines and the Boulonnais.

In 1927 when he was appointed geologist to the Cambridge Edge Island Expedition, Spitzbergen, led by H.G. (Gino) Watkins, his climbing expertise and ability were put to good

use. The geological results appeared as an Appendix to Watkins's account of the expedition (1)*. In the discussion of the report J.M. Wordie (later Sir James) said how very fortunate the expedition had been in having such a competent geologist.

## PERSIA/IRAN 1927–37

In late 1927 Norman joined the Anglo-Persian Oil Company (APOC). It, and its corporate successors, became his only employer until his retirement in 1965. His early experiences in Persia remained as an ever-present influence on his work and thinking. He left for Persia almost immediately on his return from Spitzbergen and arrived by tanker at Abadan on the 1 November 1927.

The company had met with some success drilling anticlines associated with oil and gas seeps in the Zagros Mountain foothills. By 1927 a better, but incomplete, understanding of the intensely disharmonic nature of the fold-belt and the all-important Miocene Asmari Limestone reservoir had been established. Mapping was still mainly concerned with delineating individual structures in the foothills of Khuzestan and in parts of Fars. Norman's first job was to accompany Y.P. Wilson in mapping a small anticline near Bushire.

Of those first days in Persia Norman wrote:

> I knew next to nothing about oil or South Persian geology, and had only short experience of 6″ mapping … I was doubtful whether knowledge of the UK Lower Palaeozoic was going to be of much

Figure 1. N.L. Falcon in the Iranian Makran on the joint RGS/ Imperial College London Makran Expedition 1974–76 (holding his own Makran survey map done in the 1930s).

*Numbers in this form refer to the bibliography at the end of the text.

> assistance (it did help) and felt handicapped by abysmal ignorance of the Tertiary. However the Wilson survey proved an invaluable introduction to Zagros foothills geology. I was fascinated by the tribal environment with its cheerful and tough inhabitants, still armed, in gaudy tribal dress, not yet under governmental control (10).

Subsequently Norman was sent to be the geologist on three wells at Gach-e-Garaguli (now Gach Saran), Qishn Island and the giant oil and gas complex at Agha Jari and Pazanun. Drilling at that time, using cable-tool technology, was often a tedious matter for a geologist. Recounting his early experiences (10) he recalled that the Gach-e-Garaguli No.3 well blew out but did not burn. The drilling superintendent burst into Norman's office shouting that it was all his fault—a judgement with which Norman disagreed. Norman suggested that they should see for themselves what was happening and verify whether there was a fire, laconically commenting 'before I was fired too, which wouldn't have helped very much'.

In 1930, APOC took the decision to map the complete Zagros Range at a scale of 4 miles to the inch. This project was lead by J.V. Harrison. Norman, who was about to return to England on leave, was persuaded to stay and join Harrison. Thus began a partnership of nearly eight years of fieldwork in difficult mountainous terrain, at the end of which a major contribution had been made to mapping nearly 90000 square miles of country, both geologically and topographically. Between 1930 and 1937 Norman spent almost six years in the field, broken only by short breaks in Masjid-e-Sulaiman.

A topographical surveying team, led by W.E. Browne, worked ahead of the geologists to provide a critical trigonometric base-map. The geologists' work, the product of careful observation with hammer and hand-lens, was plotted on their own topographical base-maps made with plane-table and range-finder, placed on the trig-point framework of Browne's base-map.

Thus Norman took part in the mapping of the Zagros Mountains from the Kermanshah area in the north-west (Luristan) south-eastwards through Khuzestan to the Shiraz area in north-west Fars Province, passing by Central Fars, and picking up again in south-eastern Fars and the western Makran east of Bandar Abbas. Not only had this entire region not been systematically mapped before, but much of the tribal country of the Bakhtiari and Qashqai in Khuzestan and Fars was seen by Westerners for the first time.

The territory was covered on foot with mobility provided by horse and mule packs. In Luristan, for example, the party traversed in excess of 2000 miles during the survey. In the Makran camels were substituted for the horses and mules. The relatively lower foothills country tended to be mapped in the winter months with the party moving to the 'High' Zagros in the summer months. Camp life was made as comfortable as possible, bearing in mind the constant moving and life under canvas for periods of up to 10–11 months. Norman eagerly took to the work and mode of living. He enjoyed every aspect of the life and his physical stamina became legendary. C.A.E. O'Brien writes:

> ... I heard much about him from other geologists and through tribal contacts from Kurdistan in the west, through Bakhtiari country ... to the Qashqai tribes in the east ... To the tribes he was considered remarkable for his physical endurance, being able to work all day and then beat them all back to camp.

Indeed in later life he always seemed impervious not only to physical fatigue but also to heat and cold.

A full Zagros sucession was identified from the Cambrian to the Tertiary. but little attention was paid to the pre-Permian succession. The delineation of the thick (in excess of 5000 m) Permian to Pliocene succession provided the first ordered, reasonably complete and coherent

insight to this Iranian sector of the Tethyan Province. The Zagros Mountain thrust-front, now known to mark the tectonic boundary between the Asian and Arabian Plates, was identified as a major crustal structural feature. This mapping has proved robust and has stood the test of time. Later surveys, both geological and topographical, supported by aerial photography, have refined the maps in many points of detail but have not altered significantly the conclusions of the original fieldwork.

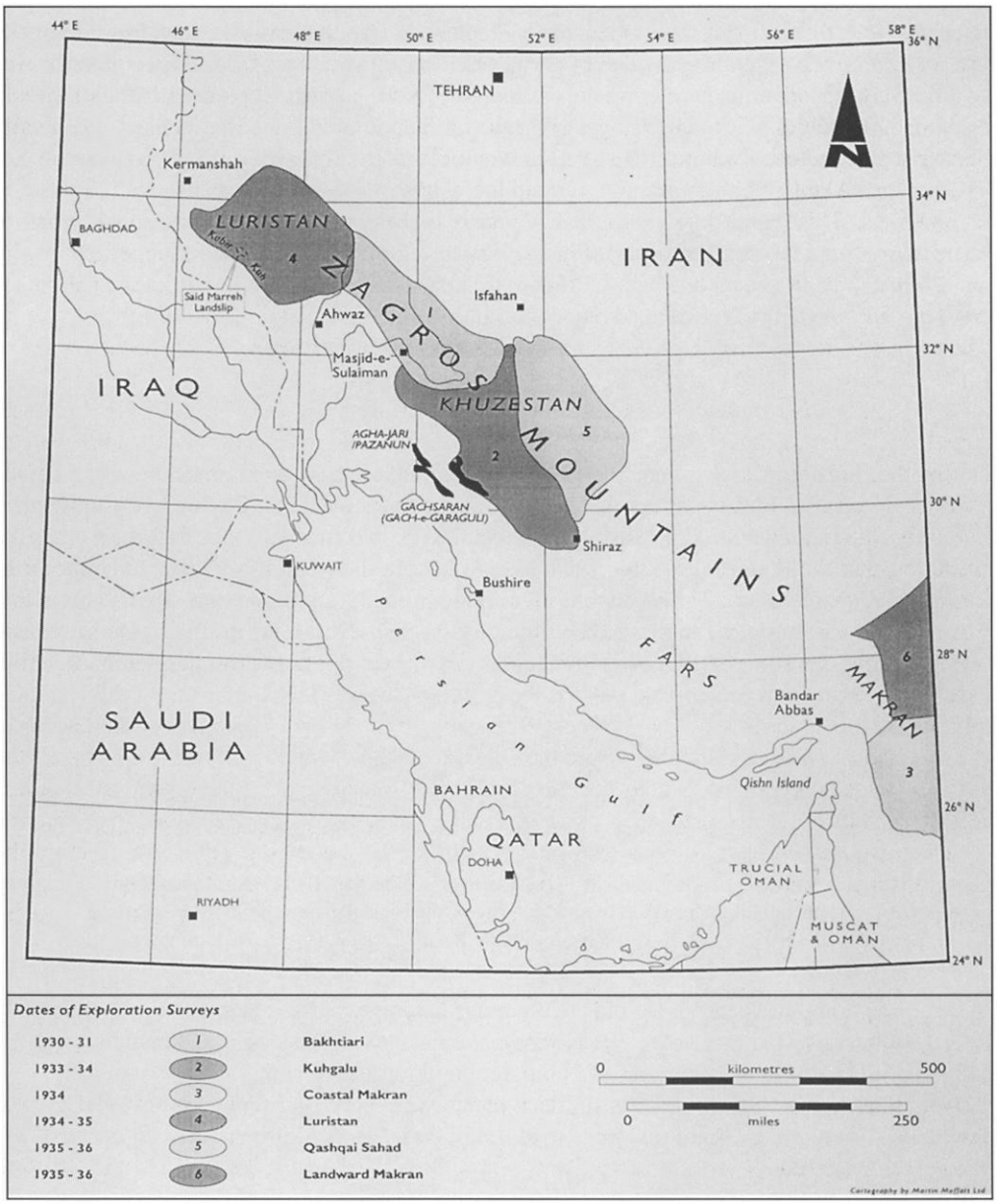


Figure 2. Map of South-West Iran displaying the Harrison–Falcon field surveys, 1930–1937.

## Return to Britain 1937–40

On his return to Britain Norman contemplated resignation from the Anglo-Iranian Oil Company (lately APOC) and studying for a medical degree. However, the Chief Geologist of AIOC, Dr G.M. Lees, F.R.S., persuaded him to stay and employed him in the team set up to explore the possibilities of onshore oil in the UK. Thus in 1938 Norman was sent to a well location at Cousland, east of Edinburgh. In the same year, possibly partly because of his lack of enthusiasm for well-site work after the excitement of Iran, he was asked again to work on Iranian geology. At this time the use of aerial photography was being developed extensively as a new and practical technique by the oil industry. Norman was seconded in 1939 to Shell in the Hague for training and to develop the aerial mapping of Iran. He also assisted in the planning of a projected joint AIOC/Shell venture in the geologically difficult country of the Makran Province in southern Iran.

In 1938 he had learnt to fly, and this, together with his expertise in aerial photographic interpretation, was to set the course of his career during the Second World War, which broke out during his secondment to Shell. In May 1940 he managed to board one of the last ships to leave for Britain as the Germans advanced through Holland.

## War service 1940–45

During the 'phoney war' Norman and Dorothy bought a house in Woking and he volunteered for military service. In the summer of 1940 he was commissioned into the Aerial Photography Intelligence Service (APIS) of Military Intelligence. Posted first to G.H.Q. Home Forces at Wembley, just as the Battle of Britain started, and later to the Central Intelligence Unit of the RAF at Medmenham-on-Thames, his recent training in the Hague stood him in good stead. At Wembley he was assigned the task of building up 'a disparate group of interpreters into an effective army section providing intelligence on enemy coastal activities and defences, anti-aircraft defences in occupied Europe, army equipment such as tanks, guns and vehicles, and military establishments ...'.

A colleague (E.W. Espenhahn) wrote that:

> Norman's technical experience, persistence, patience and personal modesty earned the respect of his contemporaries and achieved harmonious and efficient results. He ably represented the interests of the small army section in the large inter-service R.A.F. unit...
>
> APIS made a growing contribution as the war progressed and the enemy developed sophisticated weapons ... Detection of enemy sites at an early stage was instrumental in limiting their damage ...
>
> Throughout the war years Norman Falcon made a fundamental impact on the interpretation of aerial photographs and on the provision of intelligence for the army and other services.

In the preparations leading to the Normandy landings, APIS had provided essential information and by the end of the war Norman had risen to the rank of Lt Colonel and was in command of the Joint Services Aerial Photographic Intelligence Unit.

After the war he maintained his military connection, serving from 1946 to 1950 in the Territorial Army as a Major in the Royal Engineers, dealing primarily with matters of geological concern.

## Return to AIOC 1945–55

Peacetime saw Norman return to the AIOC offices in London where he picked up the work he had started on six years earlier developing an exploration programme for the UK. During the war, active exploration had met with some success in an attempt to find domestic sources of oil.

The post-war programme had limited commercial success but provided an immense wealth of data on the subsurface geology of the British Isles, which later was invaluable in the exploration of the North Sea. This work contributed especially to a better understanding of British stratigraphy, particularly of the Upper Carboniferous (Coal Measures) of the Midlands (6).

In these early post-war years, Norman continued to keep closely in touch with Iran, which remained the main focus of company activity. He worked on various compilation studies, including one on Iranian oil-seeps, which were then still the only sure indicator of hydrocarbon generation. He visited coastal Fars in early 1951 as a member of a team planning a drilling campaign in the area.

Outside Iran, but still within the Mesopotamian Basin, Kuwait developed as a major new area of interest in 1946, and through the AIOC interest in the Iraq Petroleum Company (AIOC 23.75%) Norman's involvement expanded not only to Iraq but also to the Trucial States, Oman and the East Aden Protectorate. Other areas remained of lesser, and sometimes, of ephemeral interest.

In the turmoil that followed nationalization in 1951, the company was deprived of its main source of crude oil and the decision was taken to look worldwide for other reserves. A small nucleus of geologists worked in London and Norman was made Geological Manager in 1953. He reported to and assisted Lees directly in all matters of company exploration which had to be dealt with in London and which required Head Office approval and authority. He initiated a review of all the major sedimentary basins throughout the world in order that a coherent company exploration strategy could be developed. He established a fully staffed geological library and information service within the London office that could also be used by any overseas office. Technical services were established, e.g. in photogeology, for company-wide use and he recruited a small group of specialists to form the basis of the exploration research department at the company research centre at Sunbury-on-Thames.

During this period he showed his willingness to support and try out new ideas and techniques that might have a practical value. Captain Jacques Cousteau, with his ship the *Calypso*, was commissioned at this time to attempt underwater geological mapping in the Persian Gulf. This approach led later to the mapping of the sea floor off Dorset and to Britain's first offshore well in 1961 drilled on an anticline mapped in Lyme Bay.

In his role of Geological Manager Norman took an active interest in most areas of company activity. For example, in Nigeria, where exploration was still in its infancy, he was an active proponent in encouraging Shell-BP Nigeria to move away from the Cretaceous 'framework' of the Niger Delta and to shift exploration to the Tertiary Delta itself.

## Chief Geologist, British Petroleum Company, London 1955–65

In 1955 G.M. Lees died and Norman was promoted to the position of Chief Geologist. In the same year, The British Petroleum Company returned to Iran, holding only a 40% equity in the consortium that replaced the earlier AIOC monopoly. Norman was given the mandate to find alternative oil and gas reserves outside Iran. Thus began a decade that saw BP greatly expand its exploration interests to many other countries, while maintaining a strong link with Iran and its neighbours. This worldwide programme was very successful and much of this success can be attributed to Norman.

He had learnt the lesson that to be commercially successful in oil exploration it was necessary to explore new potential provinces at an early stage. This high-risk strategy of pioneering new areas could be costly but was one which BP adopted with great success. It did not take a large staff to find the largest fields, providing they looked in the right places—a truism expressed by Professor Marr in Norman's Cambridge days (10). The onus on Norman was to pick those places. He was able to run the BP exploration programmes on what to others seemed an impossibly small staff and frequently was looked at askance when telling competitors how few geologists BP employed.

As Chief Geologist Norman had the final authority in deciding which of the ventures proposed by his technical team to back and then had the task of obtaining boardroom support. His undergraduate association with Sir Maurice Bridgeman, a BP board member and latterly Chairman, who had studied geology with Norman at Trinity, no doubt helped in this. The company's success was such that by 1965, when Norman retired, it is estimated that BP had title to about 22% of the world's oil reserves outside Soviet Russia. No company before or since has been in the same position.

During the last decade of his career, BP discovered major reserves in Abu Dhabi, Dubai, Qatar, Libya and Nigeria, and saw new major fields discovered in Iran. The work in the Persian Gulf area was perhaps of greatest interest to Norman because of past associations with the region, but the geology did not present the challenge inherent in exploring in completely new areas. Thus the offshore province of the southern Persian Gulf, covering the discoveries in Abu Dhabi and Dubai, lay in the extension of the southern Iranian salt dome province, with which he was familiar. Onshore discoveries in Abu Dhabi and Qatar similarly lay within the fold-belt pattern of the province which was well understood regionally by the 1950s.

The new areas presented many different problems, which were tackled in a methodical manner. In countries such as Libya and Arctic Alaska the geological database at the start of exploration was minimal and often reliable topographical maps did not exist. Great emphasis was placed on the initial use of geological field parties, with seismic surveys following in those areas that had been identified as important by the geologists. Drilling would follow and in this way a picture of the regional geology, with some degree of local detail, was formed. Final success often occurred some distance from the area initially chosen to commence exploration, reflecting the growth in understanding of the geology and a flexibility of thought allowing changes of focus. Thus in Libya, the areas of structurally high Mesozoic rocks of the Gebel Nefusa in Tripolitania and the Gebel Akhdar in Cyrenaica saw the start of the company's programme, but as work proceeded it became centred on the south-eastern end of the Cyrenaican Tertiary graben, where the enormous Sarir field, containing in excess of eight billion (8 000 000 000) barrels of recoverable oil, was found in 1961.

Similarly in Alaska initial work by the company caused it to reject at an early stage the

southern basins of the Gulf of Alaska and the Cook Inlet as places to explore, although small commercial fields had already been found in the Cook Inlet. The large Mesozoic basin covering the whole of Arctic Alaska was considered more attractive. Furthermore, relatively few companies at the time were active in the area. The same pattern of work was adopted and although initial drilling resulted in no commercial success, interest gradually moved, with the growth of understanding, towards the coastal Prudhoe Bay area.

Although the discovery well was drilled after Norman had retired, it was during his last two years of office that all the licences were obtained in which BP's share of the field and satellite fields lie. Thus the company holds the largest share of the oil of Prudhoe Bay, the largest oilfield in North America (14 000 000 000 barrels) and a significant share of the Kuparuk River field (4 500 000 000 barrels) as well as in some of the nearby smaller satellite fields.

Experience in the North Sea was different. The huge Groningen gasfield in northern Holland had been discovered and the geology onshore the UK was well known. The potential was recognized but rather than bid on the large, obvious structures off the Norfolk coast, Norman decided to restrict bids to the northern flank of the basin where it was believed the Permian Rotliegendes sandstone reservoirs would be best developed. Early drilling discovered the West Sole gasfield, but the giant fields, in which BP had no share, lay to the south.

Later the position in the northern North Sea showed a return to successful primary exploration in that the acreage was obtained on which the giant Forties oilfield lies, but as in Alaska, the discovery well was not drilled until after Norman's retirement.

In addition to these reserves of world significance, a steady background of exploration was carried out that gave rise to contemporary or later commercial discoveries, such as those in Colombia, Canada, Papua New Guinea, New Zealand and offshore north-west Australia. Other areas were explored and discarded, such as East Africa, Sicily and Greece. As a reflection on the embarassment of riches that the company enjoyed at this time the board decided to withdraw from Oman after the first well was dry—a decision later to be regretted.

These successes were achieved against a changing background. The end of Norman's career coincided with a period that saw the beginning of the move from dominantly onshore to offshore exploration and, shortly before he retired, the company made its first tentative use of digital computers in the acquisition and processing of seismic data. The world of oil exploration in which he had been trained and worked all his professional life, at a time when the exploration geologist's role was supreme within the oil industry, was about to change in ways that at the time could be barely perceived. Thus the exploration world with which he was totally familiar and in which he played a notable role, stood at the threshold of great changes. It peaked with success at the time of his retirement—a fitting close to his company career.

As Chief Geologist Norman read all reports, long or short, that were sent to Head Office. Sometimes they would provoke a written reply and others a passing comment when he and the author met. Whatever the reaction to a report, he kept an eye on what his staff were doing. Much of his comment related to where any particular piece of work was leading. Practical value was always important and to end a project was as necessary as pursuing it if no usefulness could be shown. Poor work got short shrift. A colleague, J.F. Watson wrote that Norman was one '... who could spot a humbug a mile away, and who did not suffer fools gladly'.

Not only was work itself important but also its presentation. Periodically he issued instructions to all geologists on how work was to be presented. In days when all colouring of

diagrams and maps was by hand, he did not want them produced in a manner that was reliant on colour for understanding. Cross-sections had to be drawn in a way that gave a serial and cohesive insight to the structure of the country under study. These directives at times seemed matters of simple commonsense but experience had told him that a diverse group of geologists, left to themselves, could produce a variety of idiosyncratic and irritating work without some experienced guidance.

He recognized early on in his career in London that administrative matters would occupy much of his time. He did not relish this, having an antipathy towards bureaucracy, but accepted it as part of his duty. Partly out of interest and partly to compensate for the time not spent on geological matters he built up a coterie of advisers, drawn from leading academic geologists, such as Professors Shotton, F.R.S., Hollingworth, Hedberg, Dunham, F.R.S., and Gill. Not only would these associates assist in keeping him and his staff abreast with developments in geology, but they also undertook reviews and visits to currently active exploration areas, and provided independent assessments. These associations, coupled with his own activities, gave Norman a good grasp of contemporary work in Britain and the USA.

## Activity in retirement

On retirement, family life and geology remained dominant in Norman's life. Most of the technical work that he did was devoted to committees and organizations that had an earth science orientation. For a number of years he remained an adviser to BP, although he was never fully at ease with this arrangement because he believed that younger men should have their chance and he did not want to give the impression of interfering.

For a period he also worked as an adviser to the Stock Exchange. He was asked to serve on numerous committees, which he did from a sense of duty, if at times somewhat critically. He never seemed to enjoy dealing with administrative matters, while recognizing that they had to be done. Too much committee work involved simply talking and not achieving. Government-sponsored committees included work for UNESCO, DSIR, NERC, the British Geological Survey, the Colonial Geological Survey and Imperial College, London. However, most of his committee involvement was centred on the Royal Society, to which he had been elected in 1960, and the Geological Society, of which he was a Fellow from 1927, later an Honorary Fellow (1988). Most of the Royal Society committees were earth science-related but also embraced government research grants and the Royal Society Library.

He served both the Geological Society and the Royal Geographical Society well. At the Geological Society he rarely missed a meeting in the days when it held Ordinary General Meetings and was a frequent visitor thereafter. He served on Council twice (1954–58 and 1967–70), as Foreign Secretary 1967–70 and as Vice President 1968–70. He expected company geologists as a matter of course to be Fellows and F.G. Larminie recalls that on visits to Head Office from abroad Norman always invited the visitor to travel with him to Burlington House by bus. Norman preferred a front upstairs seat so that he could comment on the passing scene where, unintentionally, his loud voice kept not only his guest but the whole of the top deck entertained.

His third great interest was the Royal Geographical Society, to which he donated his extensive Iranian photograph collection and, of which, he served on the Council (1966–69) and was a Vice President (1973). He was particularly interested and involved in the RGS Expeditions

Committee. It seemed that as he grew older he felt more at home in the RGS than in the Geological Society. His interest in the Middle East led to his organizing and leading the RGS expedition to Musandam in 1971–72 at the age of 67. This expedition is regarded as one of the Society's most successful in recent times. He included in the party geologists, biologists, archaeologists, ethnographers and surveyors. He later told A.J. Martin that he would like to see a core-hole drilled in the sea floor of one of the Musandam rias, as such a location might provide evidence of the Pleistocene, possibly catastrophic, flooding of the Arabian Gulf. As a result of the Musandam expedition he was invited to join the Imperial College expedition to the Iranian Makran where he was able to retrace country he had first mapped in 1936 with J.V. Harrison.

Norman was also a member of many other societies, all reflecting his interest in the natural sciences, the oil industry, geography and archaeology. He was a member of the British Association from 1930 and in 1967 served as President of Section C Geology. Others included Fellowship of the Institute of Petroleum, and memberships of the Geologists' Association, the American Association of Petroleum Geologists, the Petroleum Exploration Society of Great Britain, the Royal Central Asian Society and the Royal Institution. He strongly supported the Petroleum Exploration Society of Great Britain and frequently attended meetings, where his achievements were virtually unknown to most of the younger members.

## Publications

Rather like an iceberg the bulk of Norman's publications are not visible as he 'buried most of his research in confidential reports' (President, Geological Society 1963). Nevertheless he 'did amass a substantial corpus of published work' (Larminie 1997) and the citation accompanying his election to the Royal Society states that he was 'distinguished for his researches in tectonics and stratigraphy in connection with the exploration for oil'. It is unfortunate that these surveys were never published for they contain numerous important discussions on Iranian geology.

On becoming Chief Geologist, Norman decided to publish the Zagros Mountain mapping. The maps were presented in two series, their publication coinciding with the International Geological Congresses of 1956 and 1964. These became his most important publications and remain the standard geological reference maps for south-west Iran. The first series published in 1956 at the 20th Congress in Mexico City was at a scale of 1:1 000 000 and covered south-west Iran on a set of six sheets. A more detailed series of the same area at a scale of 1:250 000 was presented in a folio of 16 sheets at the 22nd Congress in Delhi in 1964. Each map was accompanied by cross-sections and stratigraphic notes. Additionally the 1:250 000 series was accompanied by a separate text giving a brief overview of the stratigraphy and structure that supplemented the sheet notes. The two series embody the essentials of the whole Zagros project, consisting primarily of the work of Harrison and Falcon, and remain fundamental to any study of the Zagros Range in particular and to basin development in general.

He published a number of general papers dealing with the regional geology and the oil geology of the Arabian Gulf area. Those dealing with the deeper structure of the area reflected a particular interest. In this respect one of the most significant papers was 'Major earth flexuring in the Zagros Mountains of south-west Iran (7), which identified the north–south structural cross-trends to the predominant north-west/south-east trend of the Zagros.

His Presidential address (8) to Section C of the British Assoociation provided an important

summary of Arabian Tethyan geology. Other papers synthesizing regional hydrocarbon geology deal with the UK (6) and Papua New Guinea (1961).

He was fascinated by the effects of Recent Tectonism on the landscape and archaeology in Iran and he frequently referred to these topics later, both privately and publicly. Other highlights of his publications illustrate his interest in the Late Tertiary/Recent Tectonism that has given rise to the spectacular gravity collapse and overfold structures along the the flanks of some Zagros anticlines. The classic paper, written with J.V. Harrison (2), on the gravity-collapse structures of western Fars Province clearly describes the variety and origin of such structures.

Harrison and Falcon (3, 4) also fully described the huge Said Marreh Landslide in north-west Khuzestan on the east flank of Kabir Kuh. It was recognized that this landslide had most likely been triggered by an earthquake and that it occurred as a single catastrophic event. Other large landslides had been noted in Persia earlier, but Said Marreh remains probably the largest mapped in the eastern hemisphere, displacing an estimated 17–19 cubic km of rock spread over an area of 166 sq. km.

The control by contemporary geological processes on present-day topography and thereby on human settlement and activities was admirably summarized in a paper with G.M. Lees (5) and the subject gave rise to a lifelong interest in the general geography and archaeology of Iran and the Middle East.

Although his own published work was marked by quality rather than quantity, he was convinced of the necessity for companies to publish the results of their work. In this respect, at that time, BP was an exception among the larger companies. Norman encouraged junior colleagues to publish the important parts of their work and was convinced that openess in disseminating data was of benefit to both academic and commercial interests.

His attitude to freedom of information, written in 1977, stated:

> It is by the provision of major new facts of stratigraphy and structure that the oil industry makes its contribution to truth. Although some data may have to be withheld from publication for a time because it (*sic*) represents a financial asset to the owners, the necessity passes and ultimate release is of benefit to all, stimulating further activity. ...We can only keep our sense of proportion in the earth sciences by collaboration, not fragmentation (9).

## Awards

The earliest award received by Norman was the Bronze Star presented by the US Government in 1945 for his work in Military Intelligence. His first award as a geologist came in 1952, when he received the Murchison Fund from the Geological Society. The Society subsequently awarded him the Murchison Medal in 1963, on which occasion the President said that his work in Iran 'was an achievement without parallel in oil company operations'.

In 1973 he was made an Honorary Member of the American Association of Petroleum Geologists, an honour rarely given to a geologist from outside the US. Again the accompanying citation stated that 'Norman Falcon is an outstanding field geologist and has made a notable contribution to the geological science and to oil finding'.

Honorary membership was also conferred by the Petroleum Exploration Society of Great Britain in 1980. In addition to recognition of his geological work, he was awarded, again in 1973, the Founder's Medal of the Royal Geographical Society, interestingly last awarded to a geologist in 1871 to Sir Roderick Murchison, F.R.S.

## Personality

Those who knew Norman only in a professional context would think of him as highly intelligent, austere, modest and reserved, with enormous physical energy. Those who knew him better knew that he was also a kindly man with a wealth of goodwill. The things he loved best were his family, children, the open air, mountains and good health. He was an essentially private person with a small circle of close friends, while at the same time he enjoyed the company of a wider circle of colleagues in whose company he relaxed and with whom his austere manner changed and he became open and talkative. Conversations were laced with a dry, brief wit. The same change marked his retirement. His kindliness was often evident in his defence or good word for someone being criticized by others.

Perhaps the greatest testimony to his intellect and professional ability was shown by the respect that his geological colleagues held for him. Junior staff can be the fiercest of critics and while he was often found in argument and dispute over some aspect of geology, all paid attention and respect.

An autocratic style of management was emphasized by his somewhat withdrawn manner, which in turn resulted partly from an inherent shyness, not helped by his speech impediment. He was sympathetic to others' problems, but he complained that to accommodate people's wishes he must be told of their problems, not appreciating that often his manner did not encourage familiarity.

His manner also expressed the high personal integrity that marked his behaviour. He would not condone nor lend himself to any action that suggested anything other than the highest probity. Mistakes by his staff or corporate associates were one thing; dishonesty clearly another. Those who did not know him well could be daunted by this austere and, at times, brusque style which made him seem unfriendly and distant. This manner belied his true nature, for he often showed kindnesses to all colleagues. He always supported his staff, if necessary, against all-comers and had no doubt that BP geologists and geophysicists were as good as any and better than most.

This impression of 'distance' was enhanced by his espousal of values that today are somewhat outmoded, even scorned. Patriotism and loyalty to family and friends, country and company, were strongly held beliefs that were apparent to anyone who knew him well. A Swiss colleague, Dr E. Lehner, when asked to describe Norman, simply replied 'He's very English'.

Away from the office he was a great family man and was never happier than when in the company of his children and grandchildren. He was passionately interested in their activities, proud of their achievements and loved talking about them.

In 1960, the family moved from their first home in Woking to a large Edwardian house with an extensive four-and-a-half-acre garden in Chiddingfold. Here Norman enjoyed gardening and he got much pleasure from woodworking and turning in his own well-found workshop.

He wrote (1990) that 'as an oil geologist I have for many years liked to think of the Earth as a whole ... to like Gaia (Lovelock 1979) as a useful hypothesis, because it encourages one not to waste world resources'. Practising what he preached he grew all his own vegetables and fruit and at an early stage he installed a solar panel on his roof and a heat exchanger in the house. He took part in community affairs in the village and read extensively. Both he and his wife were strong supporters of the local Yvonne Arnaud Theatre, which they frequently attended.

Norman died on 31 May 1996, having led a full, active life, at home and at work, during which he certainly gave to society as much or more than he took. Fiercely loyal, with high intellectual and ethical standards, he influenced all for the better, each in different ways. His modesty was such that he surely never thought of his life and work in that way. Those who knew him

benefited directly, but many more who did not know him were, and are, in his debt—the mark of a successful and unselfish life.

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The south-west Iran Harrison–Falcon Field Surveys Map is reproduced with the kind permission of Martin Moffatt Ltd. The photograph of Norman Falcon in the Iranian Makran on the joint RGS/Imperial College, London, Makran Expedition in *ca.* 1975 is reproduced with the kind permission of C. Vita-Finzi. The frontispiece photograph, taken in 1984, was given to the Royal Society by the Godfrey Argent Studio and is reproduced with their kind permission.

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