Obituary

JOHN STUART WEBB (1920–2007)

In 1978, publication of *The Wolfson Geochemical Atlas of England and Wales*, which showed the spatial distribution of concentrations of nineteen elements in the fine-grained (<0.177 mm) sieved fraction of samples of ~50,000 active stream sediments, collected at a spatial density of ~1 sample per 2.5 km^2 over the whole of England and Wales where surficial drainage was present, established proof-of-concept of the multi-element regional geochemical atlas as a tool capable of providing geochemical data reflecting changes in bedrock geology and overburden, as well as both natural and anthropogenic sources of pollution. It represented the culmination of a programme of systematic research begun in 1954, when Webb established the Geochemical Prospecting Research Centre at the Imperial College of Science and Technology (ICST), London. His farsighted vision of geochemical atlases as a strategic national requirement, capable of providing information of relevance to fundamental geology, mineral exploration, agriculture and animal/human health, eventually became fully realised in the UNESCO Division of Earth Sciences International Geochemical Mapping Project, inaugurated in 1988.

Webb was born in Balham, London, on 28 August 1920, the eldest child of George Stewart Webb and his wife Caroline Rabjohns (*née* Pengelly). Educated at St. Mary's School, Balham (1925–30) and Westminster City School, London (1930–38), he graduated BSc (First Class Honours) in Mining Geology from ICST in 1941, having been awarded the Murchison Medal (1939), the Brough Medal (1940), the Clement le Neve Foster Prize (1941) and the Cullis Testimonial Fund (1941).

After a brief period as assistant mining geologist to the U.K. Government's Non-Ferrous Metallic Ores Committee, he served as a sapper in the Royal Engineers (1941–43) and was commissioned Second Lieutenant before being transferred

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to the Geological Survey of Nigeria (1943–44) as an economic mineralogist to look for tantalite, as at the time tantalum was vitally needed for the development of radar. In the course of this work, together with R.R.E. Jacobson, he discovered a new tin mineral, nigerite, $Fe^{2+}_{0.4}Zn_{0.4}Mg_{0.3}Fe^{3+}_{0.1}Sn_{1.8}Zn_{0.2}Al_{10.5}Fe^{3+}_{1.5}O_{22.2}(OH)_{1.8}$ (today known as ferronigerite-2N1S), in quartz-sillimanite rocks associated with the tin-bearing pegmatites in the Egbe district of Kogi State, Central Nigeria. Their discovery, first mentioned in the Report of the Nigerian Geological Survey for 1944, was fully described in this journal (**28**: 118–128) in 1947. Their work also established that there were two distinct periods of tin-mineralization in Nigeria, associated with the Older and Younger Granites, respectively. Unfortunately, Webb's stay in Nigeria was terminated as a result of his contracting tick-typhus. Following hospitalization in Kaduna for three months, he was then unlucky enough to contract malaria, which became complicated by black-water fever. Declared unfit to travel by sea, he was flown, via Dacca and Lisbon, back to London.

Following his recovery, Webb was awarded a Beit Scientific Research Fellowship in Professor David William's Department of Mining Geology at ICST and began a study of 'The origin and mineral paragenesis of the tin lodes of Cornwall', for which he was awarded the Judd Prize (1946) and a PhD, from the University of London, the following year. He was then appointed Lecturer in Mining Geology at ICST (1947–55), at a time when the Department was beginning a research programme embracing the study of mineralization in Cyprus, Portugal, Uganda, West Africa, Southern Rhodesia (Zimbabwe) and Great Britain.

In 1948, Webb was awarded the Daniel Pidgeon Fund of the Geological Society of London to investigate Hercynian tin-tungsten mineralization and from 1949 (later assisted by his research student, A.R. Barringer) he pursued a long-term study of the geology of the San Domingos (volcanogenic) massive sulphide deposit, near Mértola, Portugal, demonstrating its similarity to orebodies in the province of Huelva, Spain.

However, aware of early Russian and Scandinavian work on the application of geochemistry to the search for mineral deposits and the fact that the U.S. Geological Survey had established a Geochemical Prospecting Unit in 1946 under Herbert Hawkes (1912–1996), Webb was keen to investigate the scope of such methods (then an unknown subject in Britain). In July 1949, together with his colleague, Assistant Lecturer A.P. Millman, he began research in exploration geochemistry, firstly on the distribution of heavy metals in plants and waters in areas of lead-zinc mineralization in the Nyeba (Enyigba) district of southeastern Nigeria; and later in residual soils and plants over sub-outcropping tin-copper lodes in Cornwall and in soils over a deeply buried lead-zinc lode in Derbyshire.

As a result of Webb and Millman's work in Nigeria, in 1951–52, Hawkes undertook a pioneering study of the utility of geochemical prospecting for lead-zinc mineralization in residual tropical soils over the same lodes whose pattern of dispersion Webb and Millman had examined in 1949, using water and vegetation samples. Unfortunately, Hawke's analytical procedure, which used an acid attack, failed to find any significant anomalies over the lodes and he assumed that prospecting in areas of thick lateritic soil cover would not work. Passing through London, Hawkes left cuts of his samples with Webb (who found in 1953 that analysis of the samples using a bisulphate attack produced an excellent anomaly; J.S. Tooms, pers. comm.) and in 1952, at Hawkes invitation, Webb undertook a six-week tour of the exploration geochemistry being undertaken by mining companies across North America, the U.S. Geological Survey and by Harry Warren (1904–1998) at the University of British Columbia. On his return, Webb proposed the establishment of a British programme to provide its mining industry with geochemical methods of exploration applicable to tropical terrain.

The Geochemical Prospecting Research Centre (GPRC) was established at ICST in 1954, with Webb as its Research Director. Over the years, he pursued his objectives with single-minded tenacity, often in the face of considerable scepticism. He became Reader (1955–61) then Professor of Applied Geochemistry (1961–79). Early studies focused on mineral prospecting, mainly in Africa, Asia and Australia, using soil and drainage sampling. He co-authored with Hawkes *Geochemistry in Mineral Exploration* (1962; subsequently revised with A.W. Rose, 1979) which has remained the standard text on the subject.

In 1954 and 1955, with finance having been secured by Webb from London, he participated

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with Hawkes and others in a pioneering survey exploring for base-metal deposits >27,000 mi^2 (69,000 km^2) of eastern Canada, based on chemical analysis of the fine-grained (<0.177 mm) sieved fraction of samples of stream sediments (a sampling medium hitherto untried at that scale) which proved its effectiveness as a low-cost exploration method.

Webb realised that similar, multi-element, surveys might eventually produce cost-effective geochemical maps useful to the understanding of regional geology. His multi-element regional mapping concept had its first successful test in 1960, using drainage samples collected over 3,000 mi^2 (7,800 km^2) of the Namwala-Livingstone area, Zambia. By 1966, its efficacy had also been proved in Sierra Leone.

Webb now began studies to investigate the relationship between regional geochemistry and agricultural problems in livestock, firstly in Ireland in 1963, then in Devonshire, Denbighshire and Derbyshire (the first regional-scale drainage surveys in Britain) in 1965. Studies in marine mineral exploration also began in 1964, and to reflect the increasing scope of its work, GPRC was renamed the Applied Geochemistry Research Group (AGRG) in 1965.

By 1966, it was shown that regional drainage surveys could indicate areas of potential disease in cattle and sheep at clinical and (of particular economic importance) at sub-clinical levels. Webb recommended in 1970 that, particularly in developing countries where people tended to eat more locally-grown produce, regional geochemistry should form part of any systematic study of trace elements and human health. In 1971, AGRG began a programme to identify the severity of contamination in the urban, agricultural and marine environments as a result of pollution related to human activity. The pioneering *Provisional Geochemical Atlas of Northern Ireland* (1973) and *The Wolfson Geochemical Atlas of England and Wales* (1978) confirmed Webb's view that regional geochemistry could provide an invaluable addition to conventional geological mapping.

By his retirement in 1979, over 80 PhD students had been trained in the GPRC and AGRG, many of whom went on to leading positions world-wide in the mining industry, geological surveys and academia. Technology-transfer of methods developed by the Group to the mineral exploration industry had been wholly successful, as had studies related to environmental and marine geochemistry.

Webb was awarded DSc of London University, 1967; the Institution of Mining and Metallurgy Consolidated Gold Fields of South Africa Gold Medal, 1953, and the Geological Society of London's William Smith Medal, 1981. He was elected Honorary Member, Association of Exploration Geochemists, 1977; Fellow, Royal Academy of Engineering, 1979; and Honorary Fellow, Institution of Mining and Metallurgy, 1980. Nevertheless, although acclaimed abroad, recognition by many of his peers in Britain of the importance and pioneering nature of the work undertaken, under his guidance, by the GPRC and AGRG over the years was lacking. It is scandalous that he was never elected to the Royal Society.

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