Robert E. Ogilvie

1923 - 2013

Brief biography

Ogilvie was born in Wallace, Idaho and graduated from high school in Spokane, Washington in 1941. During the war, he started at Boeing to support his studies at the University of Washington, which were interrupted by a stint in the Navy Air Corps. In 1950 he received his bachelors from UW, and was admitted to MIT with the goal of earning a PhD in physics, which by way of Masters and Engineers degrees, he did in 1955. He studied x-ray absorption analysis under Professor John T. Norton.

He had already become a professor at MIT in 1953, with research interests in diffusion and x-ray microanalysis. He continued at MIT, finally as professor emeritus of metallurgy in the Department of Materials Science and Engineering. He was the major thesis advisor of a number of students who contributed to microscopy and instrumentation development (Lyman, Ziebold, Morris, Brown, Goldstein, and others).

Frames from the video interview recorded at Ogilvie's home by John Fournelle, in 2012.

At MIT, he taught "Fundamentals of Crystallography and X-Ray Diffraction," "Electron Optics," "Materials Laboratory," and "Celestial Navigation." He directed the X-Ray and Electron Optics Lab at MIT and served as president of the Electron Probe Analysis Society of America. An avid sailor, he sailed "Op-Tiki," a 36-foot Cheoy Lee ketch (such as pictured to the right), around the world with his son Rob.

In retirement, he worked part time at the Boston Museum of Fine Arts applying x-ray techniques to investigate the detection of art forgeries made available to the museum, the construction of samurai swords, and the analysis of meteorites.

Early microprobe instruments

While still a graduate student, he became aware of Castaing's paper on the microprobe, and upon becoming a professor, he and his student Richard Macres modified an old RCA EMB TEM into a microprobe instrument (while Castaing had also started with an EMB, Ogilvie took an independent approach). The instrument had sufficient spatial resolution to get good plots of a Cu-ZN diffusion couple.

A new lens was needed to enable viewing of the sample with a light microscope during bombardment with the electron beam. This led to the construction of a new microprobe, which used a Philips electron gun. This instrument was very productive at MIT, and a second one had to be built to satisfy the demand. Later, MIT acquired an ARL probe, and then a Cambridge Stereoscan SEM to which solid-state detectors were added.

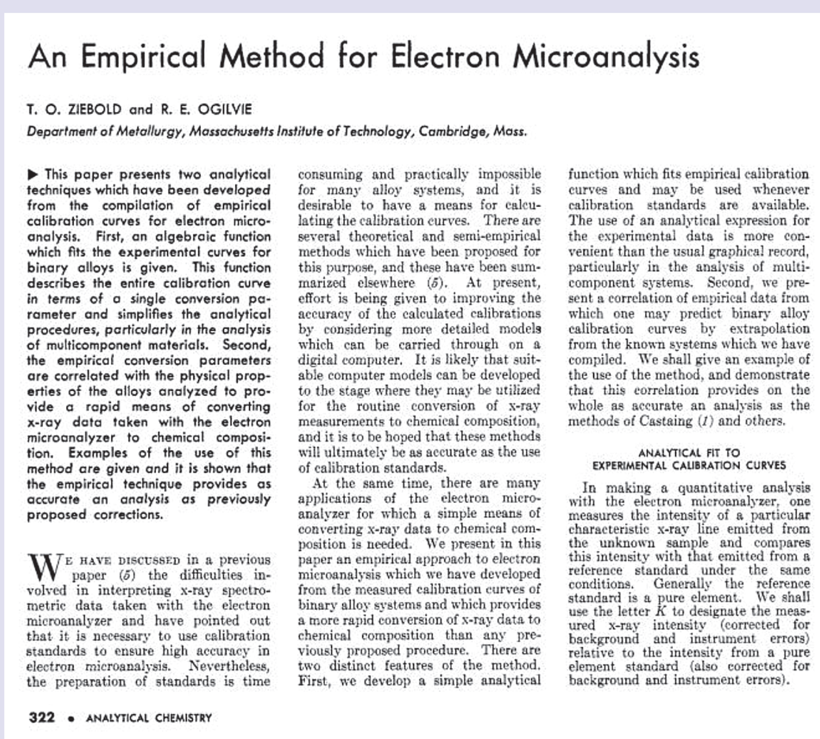
Pioneering scientific contribution

Ogilvie's major contribution to x-ray microscopy was the development of the "a" (aka "alpha") factor, (Ziebold and Ogilvie, 1963, 1964) for x-ray microanalysis. In the early 1960s the ZAF method was not well developed and analysis errors were often quite significant. Furthermore, computer data reduction was less generally available. In response to this state of affairs, Ziebold and Ogilvie developed an empirical correction method for quantitative analysis of binary alloys. Using the "a" factor, the intensity ratio sample to standard of element 1 is related directly to the concentration of element 1 in the sample for a given electron beam energy and take-off angle. The popularity of this method increased greatly when it was further developed by Bence and Albee (1968) and applied in geological analysis. The Bence-Albee analytical technique has played an important role in x-ray microanalysis in geology, and their paper has been one of the most cited articles in the geological sciences.

Ziebold, T.O. and Ogilvie, R.E. (1963) Quantitative Analysis with the Electron Microanalyzer, Anal. Chem. 35:621-627.

Ziebold, T.O. and Ogilvie, R.E. (1964) An Empirical Method for Electron Microanalysis, Anal. Chem. 36:322-327.

Bence, A.E. and Albee, A. (1968) Empirical correction factors for the electron microanalysis of silicates and oxides, J. Geol. 76:382-403.



An Empirical Method for Electron Microanalysis

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▶ This paper presents two analytical techniques which have been developed from the compilation of empirical calibration curves for electron microanalysis. First, an algebraic function which fits the experimental curves for binary alloys is given. This function describes the entire calibration curve in terms of a single conversion parameter and simplifies the analytical procedures, particularly in the analysis of multicomponent materials. Second, the empirical conversion parameters are correlated with the physical properties of the alloys analyzed to provide a rapid means of converting x-ray data taken with the electron microanalyzer to chemical composition. Examples of the use of this method are given and it is shown that the empirical technique provides as accurate an analysis as previously proposed corrections.

We have discussed in a previous paper (*5*) the difficulties involved in interpreting x-ray spectrometric data taken with the electron microanalyzer and have pointed out that it is necessary to use calibration standards to ensure high accuracy in electron microanalysis. Nevertheless, the preparation of standards is time consuming and practically impossible for many alloy systems, and it is desirable to have a means for calculating the calibration curves. There are several theoretical and semi-empirical methods which have been proposed for this purpose, and these have been summarized elsewhere (*5*). At present, effort is being given to improving the accuracy of the calculated calibrations by considering more detailed models which can be carried through on a digital computer. It is likely that suitable computer models can be developed to the stage where they may be utilized for the routine conversion of x-ray measurements to chemical composition, and it is to be hoped that these methods will ultimately be as accurate as the use of calibration standards.

At the same time, there are many applications of the electron microanalyzer for which a simple means of converting x-ray data to chemical composition is needed. We present in this paper an empirical approach to electron microanalysis which we have developed from the measured calibration curves of binary alloy systems and which provides a more rapid conversion of x-ray data to chemical composition than any previously proposed procedure. There are two distinct features of the method. First, we develop a simple analytical function which fits empirical calibration curves and may be used whenever calibration standards are available. The use of an analytical expression for the experimental data is more convenient than the usual graphical record, particularly in the analysis of multicomponent systems. Second, we present a correlation of empirical data from which one may predict binary alloy calibration curves by extrapolation from the known systems which we have compiled. We shall give an example of the use of the method, and demonstrate that this correlation provides on the whole as accurate an analysis as the methods of Castaing (*1*) and others.

ANALYTICAL FIT TO EXPERIMENTAL CALIBRATION CURVES

In making a quantitative analysis with the electron microanalyzer, one measures the intensity of a particular characteristic x-ray line emitted from the unknown sample and compares this intensity with that emitted from a reference standard under the same conditions. Generally the reference standard is a pure element. We shall use the letter K to designate the measured x-ray intensity (corrected for background and instrument errors) relative to the intensity from a pure element standard (also corrected for background and instrument errors).

322 • ANALYTICAL CHEMISTRY

AMR / AMRAY

Ogilvie proposed starting a consulting company, to be called Advanced Metals Research Corp. (AMR), which initially had three commercial probes. He had a number of different collaborators, both in starting the company and in later work, one of whom was his former Professor, John Norton. He and Bill Morris built an early SEM at AMR. One of the projects was analysis of upper-atmosphere dust particles collected by the Air Force using the U2. Although the workload became so great that Ogilvie decided to quit AMR and remain and MIT, AMR went on to become AMRAY, the first US manufacturer of SEMs. An early AMR-1000 is shown here.

Founder of MAS

Ogilvie was a founder of EPASA (Electron Probe Analysis Society of America), the forerunner of MAS (Microbeam Analysis Society, now Microanalysis Society). He organized the "famous" 3rd US microanalysis meeting at the Summerset Hotel in Boston with major support from industrial sponsors. The society social that year has gone down in history as the best ever. Ogilvie was President of the society in 1970 and was elected an honorary member of MAS in 1986. He also started a week-long summer course in X-ray microanalysis in the 1960s with such notable instructors as Raymond Castaing and Jean Philibert. This course eventually moved and grew to become the Lehigh summer course in microscopy.

Research interests

While active at MIT, he began working with William Young, founder of the Research Lab at the Museum of Fine Arts, Boston, and developed a long collaboration and supportive relationship with what is now the Department of Conservation and Collections Management at the MFA, as well as with conservators and conservation scientists there and elsewhere. He was instrumental in establishing the series of workshops and publications on the Application of Science in the Examination of Works of Art. His use of the electron microprobe in detecting forgeries and authenticating art was the subject of cover stories in Technology Review and Saturday Review.

Osculating elements from astorb-database for 3973 Ogilvie

More information regarding 3973 Ogilvie in English wikipedia (external link)

Number	Name or designation	Mean Anomaly M (degrees)	Long. of Perihelion Argument w (degrees)	Long. of Perihelion L (degrees)	Long. of Ascending Node o (degrees)	Inclination i (degrees)
3973	Ogilvie	52.81695	244.56735	315.61437	71.04702	1.849233

Eccentricity e	Semi major axis a (AU)	Perihelion distance (AU)	Aphelion distance (AU)	Period (years)	Epoch (date)	observations (no)	diameter (km)
0.2087706	2.3573170	1.865178	2.849455	3.619319	20140523	143	N.A.

Discovery data for 3973 Ogilvie

Number	Name	Designation	Date of discovery	Site of discovery	Discoverer(s)
3973	Ogilvie	1981 UC1	1981 10 30	Socorro	Taff, L. G.

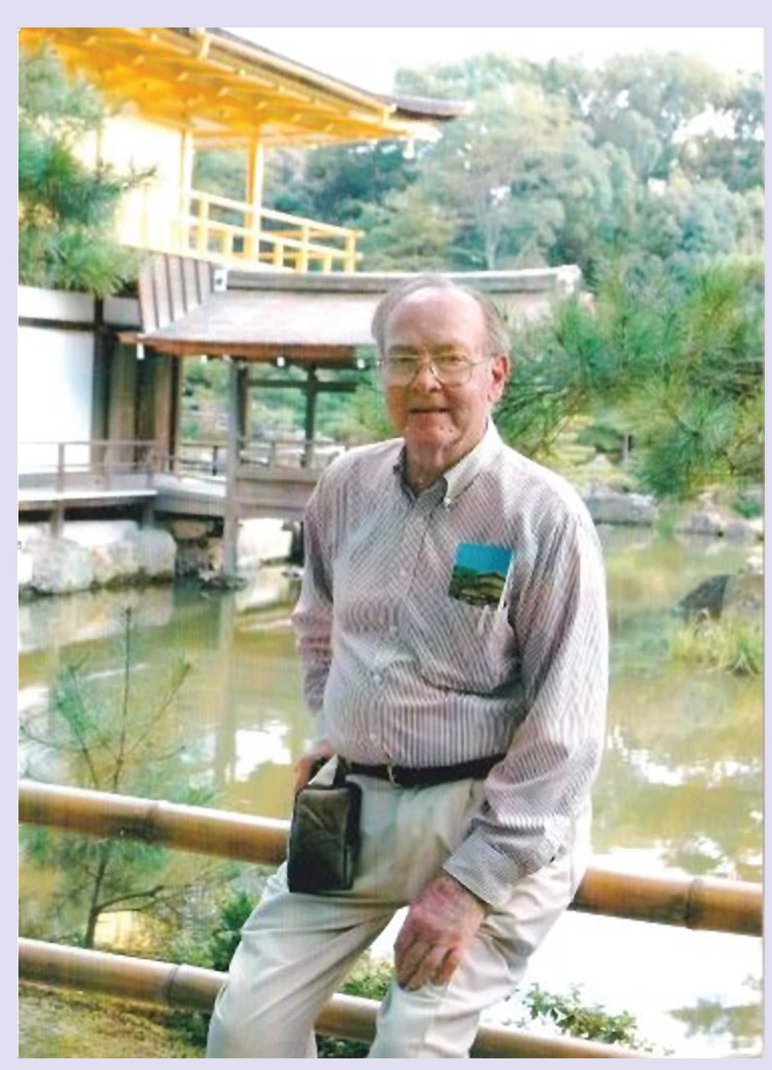
Source: Discovery Circumstances of Numbered Minor Planets by Minor Planet Center

Another application of the electron microanalyzer was the examination of meteorites. The instrument could determine the objects' thermal history and the size of the original body of which the meteorite was a fragment. Ogilvie was a member of the Harvard-Smithsonian Meteorite Discussion group, and in 2000 he was recognized for his long-time involvement and contributions with a named minor planet, 3973 Ogilvie, which was discovered in 1981.

Ogilvie had a long fascination with the creation and structure of samurai swords, leading him to visit swordmakers in Japan, including the famous Gassan family, to see how swords were made. He worked with his students on the processing and compositional changes that took place as a result of heat treatment. His extensive collection of samples and data has been invaluable for students and scholars.

At the right, he is shown later in life at Kinkaku-ji in Kyoto.

Above, he is shown at the first US-Japan meeting on Microanalysis, which he organized, held in Hawaii about 1970; he participated in the second meeting a few years later.



Acknowledgements

This poster is an adaptation and synthesis of:

J. I. Goldstein (2014) Robert E Ogilvie: Inventor, MAS Founder, and Educator. Proceedings IUMAS-6.
J. Fournelle (2014) From the Archives by John Forunelle. MAS Micronews, Fall 2013.
The "MIT News" webpages.