MARY "POLLY" PORTER (1886-1980): PIONEER WOMAN CRYSTALLOGRAPHER

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Introduction

In an Obituary for Nobel Laureate, Dorothy Crowfoot Hodgkin, it was stated that, for her fourth year undergraduate research project (1): "... she [Hodgkin] was anxious to return to crystallography. She was greatly encouraged in this by Dr Polly Porter, a Research Fellow at Somerville, who had worked for years measuring and cataloguing crystals."

Hodgkin referred to Porter in a Public Lecture Hodgkin gave in 1979 titled "Crystallography and Chemistry in the First Hundred Years of Somerville College." In that lecture, she elaborated upon her contact with Dr. Mary "Polly" Porter (2):

> ... I wavered little in my determination to do Crystallographic research for Part II Chemistry. ... So I talked it over with H. M. Powell and also with Polly Porter and agreed to begin in September. Before that Polly Porter had advised me to go to Germany, to work for a few months in the laboratory of old Professor Viktor Goldschmidt, a particular friend of hers. He had designed a two-circle goniometer for measuring crystals—Polly bought one of these for Oxford—and also devised a good method of drawing crystals which I learned.

***Figure 1**. Mary "Polly" Winearls Porter and her mother, Alice, from Wikimedia Commons (4).*

Yet Porter's role as pioneer woman crystallographer has never been recognized. Here we will describe the unusual life-path and contributions of Mary "Polly" Winearls Porter, an individual who deserves remembrance—among many things—for being an extremely talented classical crystallographer before, and overlapping with, the era of X-ray crystallography.

Porter's Early Years

Born in King's Lynn, Norfolk, England, on 26 July 1886, Mary Winearls Porter (Figure 1), known by all as Polly Porter, was the daughter of Robert Percival Porter and Alice Porter (née Hobbins) (3). Polly had twin elder brothers, one of whom died young, plus two older step-brothers from her father's first marriage. The family moved back to the United States when Polly was two years old. For most of his

working life, her father was a newspaper journalist and editor. The family travelled frequently, usually taking Polly with them, which precluded formal schooling for her. In fact, Robert Porter believed that education was unnecessary for women and, as a result, she only received a basic home education in reading and writing.

From 1901 to 1902, Porter was in Rome with her sick and bed-ridden mother while her father held an appointment as Special Commissioner in Cuba and Puerto Rico. Her mother's English nurse, a nun of the "Blue Sisters" Catholic Nursing Order, sometimes took 15-year-old Porter sight-seeing. Porter had three family friends who also took her out: Henry Wickham Steed, Rome correspondent of *The Times*; Signor Giacomo Boni, who was in charge of excavations at the Roman Forum; and Count Domenico Gnoli Sr., an antiquarian.

Porter provided an insight into her early life in autobiographical notes. These notes, titled "A Personal Tribute by The Author" are buried within the typescript of *The Diary of Henry Alexander Miers 1858-1942* (5). Completed by Porter in 1973, they provide details of her time in Rome.

In these autobiographical notes, Porter recalled (5):

> These kind friends took me to see Churches and some of the great archaeological sites. Perhaps the greatest interest these aroused in me was the striking beauty and variety of the coloured marbles to be seen everywhere in Rome, and the temptations displayed for sale in the little open windows of stonecutters' shops. ... Signor Boni took me over the Forum and added to my collection fragments of marble from the rubbish heaps there and Conte Gnoli gave me an Etruscan terracotta foot dug up on his estate.

In 1902, Porter's father arranged to be a sales agent in Britain for the Tabulating Machine Company and the Porter family settled in Oxford. Then 16 years of age, Porter was delighted with the news. Oxford University, as she discovered, held the Corsi Collection of about 1,000 specimens of marble varieties.

It was in the first quarter of the 19th century that Faustino Corsi, a lawyer and later a judge, collected specimens of stone types used by the ancient Romans (6). These polished marble slabs were of uniform size, about 145 mm □ 73 mm □ 40 mm, large enough to ascertain the bulk colours, texture, and patterns of the particular marble variety. Corsi went far beyond simple collection, categorizing them into classes depending upon their mineral composition, the nature of any veins, and other characteristics. He compiled the information on his collection of building stones, including the quarry location, in a 248-page book: *Catalogo Ragionato D'Una Collezione Di Pietre Di Decorazione*. The Collection was purchased and donated to Oxford University in 1827. However, over the following decades, the Collection became ignored, gathering dust, with labels detached, and some samples having been removed for such purposes as door-stops.

Porter and Sir Henry Miers

Upon arrival in Oxford, Porter took her samples to the Oxford University Natural History Museum to identify them by comparison with those in the Corsi Collection. It was the observation by the mineralogist, Sir Henry Alexander Miers (Figure 2), of this young woman's repeated visits to view the Corsi Collection which caused him to introduce himself to her. At the time of their first encounter, Miers held the Wynflete Chair of Mineralogy at Oxford (7).

***Figure 2**. Sir Henry Miers (©National Portrait Gallery, London, Sir Henry Alexander Miers by Walter Stoneman, bromide print, 1933, NPG x186625)*

This meeting and subsequent events were described in Porter's autobiographical notes (5):

> Our first meeting was in the summer of 1902 during one of my frequent visits to the Museum. He had noticed them and presently came and asked me what my interest was. From that time his practical help and interest did not cease throughout the remainder of his life. ... The Professor encouraged me to study the marble collection, and he gave me a few small tasks in this connection which resulted in some rearrangement, the translation of the Italian catalogue, ...

Of course, Porter's comments about undertaking "a few small tasks" was far from the truth. Translating the Corsi catalogue from Italian (in which she was fluent) and re-labelling the Collection was a massive project.

Porter's role was highlighted in the History of the Oxford University Geology and Mineralogy Department (8):

> Henry Miers had done what he could to clean the grime of ages off the specimens and to rescue as many of the labels as possible, but the collection was nonetheless in a poor condition when, having observed the young Mary Porter examining the indifferent display in the Museum Court, he asked her one day whether she was interested in these specimens and whether she would like to work with them. She agreed eagerly and set about the translation of Corsi's Italian catalogue so that specimens which had lost their original labels could be identified and re-labelled, and assisted Miers in the rearrangement of the collection.

In addition to cataloguing the Collection, Porter corresponded with William Brindley, co-director of the stone contractors, Farmer & Brindley (9), who specialized in the procurement of ancient marbles. Through her correspondence with the Company, Porter was able to obtain additional marble samples which she described, catalogued, and accessioned to the Collection.

Between 1902 and 1908, Porter's family spent the winters in the United States, where her father was special Washington correspondent for *The Times*, and the summers back at Oxford. Porter recalled Miers mentorship during those summers (5):

> ... Professor Miers had the patience and kindness to introduce me little by little to minerals and their crystals. Crystallography "the Queen of all the Sciences," came first in his love of science. The striking outward shapes of crystals, with the complexity of their internal structure, certain, but not yet defined by X-rays in those days, led me to the desire to know more of their elementary attributes. The height of my ambition in those days was "to do crystal calculations," ...

Just as her brothers had pleaded with her parents unsuccessfully to allow her to obtain an education, so Miers' attempt proved equally fruitless (5): "In the last years of his professorship Sir Henry pleaded with my parents to let me remain at Oxford to be coached for the University entrance examinations; unfortunately the plea was not successful."

Porter's Book: *What Rome Was Built With*

During her time with Miers in Oxford, Porter had been writing a monograph on the varieties of marble types. It was in 1907, at the age of 21 that it was published, titled *What Rome Was Built With: A Description of the Stones Employed in Ancient Times for its Building and Decoration* (10). In the Preface, Porter described the metamorphic nature of marbles, continuing (10):

> Of limestones from which the greater part of marble is derived there are two varieties, the most common being formed of the hardened calcareous remains of plants and animals, that is, of organic origin. The other variety is of inorganic formation, and is deposited by water carrying carbonate of lime in solution, thus forming sheets of limestone. ... It is difficult to ascertain from which of these two formations a marble may be derived, as in crystallization all fossil remains are often entirely obliterated.

Porter then addressed the chemistry (10):

> Marble, when formed of carbonate of lime without impurities, is pure white, as, for instance, statuary marble. The presence of other substances leads to various colorations. Yellow, pink and red tints are as a rule due to iron oxides; blue-grey, grey and black to carbonaceous matter derived from organic remains.

The marble nomenclature of the time then comes in for Porter's criticism (10):

> The guides are not to be trusted as to the names of marbles, which are invented by the stone-cutters, and are usually merely descriptive of colour or marking, or of some other peculiarity, and which for the most part bear no reference to the true geological character of the stone or the locality whence it comes.

Porter's research was incredibly thorough. In addition to the Corsi collection of 1,000 marble slabs at Oxford, she was able to access and study the 800 slabs at the Musée Cinquantenaire at Brussels, and the 600 slabs at the British Museum in London.

Following publication, reviews of the book appeared in several academic journals. It is probable that none of the academic reviewers had any idea that "Miss Porter" was barely 21 years old and had no academic qualifications whatsoever. In *The Antiquary*, the reviewer, George Latimer Apperson, wrote (11):

> Miss Porter has hit upon an almost untrodden by-way in classical history and topography, and in this scholarly and well-written volume−the product evidently of wide and deep and well-ordered knowledge−discusses the marbles, the variety of stone and marble, which were used in the construction of Imperial Rome. ... Miss Porter's monograph is an excellent piece of work.

A more critical review was given by "S. B. P." in *The Classical Weekly* (12): "This handbook, when revised, will be a useful addition to the library of the classical scholar. ... In general the description of the stones is

correct, and that of the quarries useful and interesting, but the book is written in a somewhat hap-hazard style." The reviewer for the *Bulletin of the American Geographical Society* was more neutral in his opinion (13): "The author has ransacked literature for all it will yield relating to the rock materials used in the building of Rome in ancient times and later. ... The author chose a unique and edifying topic and has treated it in an interesting and adequate manner."

Porter's book also came to the attention of the popular press. She was interviewed by *The Boston Globe* in an article titled "Writes of Roman Marbles" (14), the same lengthy interview being reproduced in *The Washington Post* under the heading: "Young American Girl Wins Fame As Authority on Roman Marbles" (15).

The *Boston Globe* reporter commented that Porter had commenced upon the venture when she was "less than sixteen years of age" (14):

> Miss Porter's work as a classifier of marbles, as well as an author, has been of an unusual character, considering her age, for she is scarcely 21. The amount of commendation bestowed upon it has quite disconcerted the young author, whose modesty has as yet restrained her from coming before the public.

Even at the age of twenty-one, Porter's parents were controlling her life, as the reporter noted:

> The critical papers of England have bestowed praise on the work as one of unusual accuracy, and Miss Porter has received, as a result of the book and her labors at Oxford, offers from other museums abroad to classify and catalogue their collections of minerals and marbles. These offers she has declined, as her parents think her too young to take up such work at present.

Porter's Research in London

In 1908, Miers accepted a position of Principal of the University of London. During the Winter of 1910-1911, Porter happened to be residing in London with her parents. Miers invited Porter to a dinner whose other guests included Dr. A. E. H. Tutton (16), one of Miers's outstanding former students, and his wife. Porter recalled in her autobiographical notes (5):

> I sat next to Dr. Tutton and he asked me if I would like to work in his laboratory during the months we were in London. I grasped the opportunity. My duty was to dust the laboratory, and in the short times when we were together he taught me to weigh out chemicals, and make up solutions ready for crystallization, watch for the growing crystals, remove them from the liquid, dry them carefully with fragments of filter paper ready to put away for measurement. Finally I was promoted to the measurement itself. This occupation terminated to my regret in the summer [of 1911] when we went to America, but my determination was fixed to become a crystallographer.

Tutton's major research was on ionic compounds containing two different cations and the effect of changes in the cation identities on the crystal form. These compounds are now called "Tutton's Salts" (17). The research undertaken by Porter was published in *The Mineralogical Magazine and Journal of the Mineralogical Society* in 1912 with Porter named as co-author (18). Thus Porter, without formal education, who had already authored a monograph, was now co-author of a lengthy research publication.

Porter's Years in the U.S. and Germany

Upon arrival in the U.S. in 1911, Porter was hired by George P. Merrill, Head Curator of Geology at the National (Smithsonian) Museum in Washington for a nine-month period (19). The work involved cataloguing the thousands of samples of marble, granite, sandstone, and other rocks which came from established quarries across the United States. When a public building was to be constructed anywhere in the country, these four-inch cubes were used to identify the possible building stones from the vicinity of the construction site.

In early 1913, the Porter family moved to Munich (probably another journalistic appointment of her father). During the sojourn in Munich, Porter worked under Paul Heinrich von Groth. Groth was Professor of Mineralogy and Curator of the Mineralogical State Collection in Munich in addition to being Full Professor of Chemistry at the University of Munich.

By the Summer of 1913, Porter had returned to the United States, where she was accepted as a graduate student at Bryn Mawr College, Pennsylvania, despite her lack of an undergraduate degree. One of the faculty at Bryn Mawr was Florence Bascom (Figure 3), the most prominent American woman geologist of the period (20). The funds the family provided for Porter were not enough for her to live on. To help Porter survive financially, Bascom arranged for Porter to have a paid position which primarily involved organizing and cataloguing the Rand Collection of Minerals in Bryn Mawr's Geological Museum. While doing this, Porter separated out perfect crystals for subsequent crystallographical study.

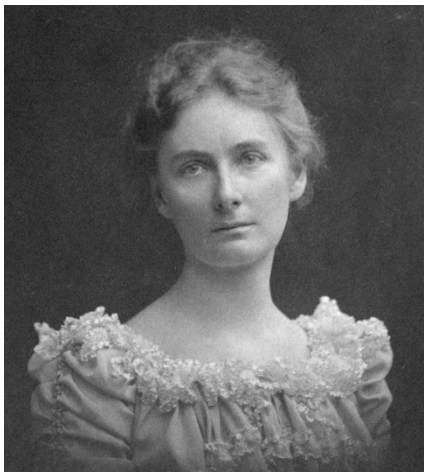

Figure 3*. Florence Bascom, from Wikimedia Commons (21).*

Bascom, herself, had spent part of her sabbatical year of 1906-1907 at the University of Heidelberg. During the later 19th and early 20th centuries, the University of Heidelberg was at the forefront of research in geology and mineralogy, as Mahler and Pfefferkorn have commented (22):

> The University of Heidelberg, in Heidelberg, West Germany, had a significant influence on the development of the geological sciences in North America between 1860 and 1913. ...The students came to Heidelberg to learn the newest techniques from professors such as Rosenbusch, Bunsen, and Salomon Calvi. They also learned to develop theories based on the technique of detailed and careful observation that these men used.

During her time at Heidelberg, Bascom studied with the German mineralogist and crystallographer, Victor Mordechai Goldschmidt (23) (not to be confused with the more famous Norwegian mineralogist, Victor Moritz Goldschmidt). Goldschmidt had compiled all available data on crystal forms of minerals and published them in a three-volume encyclopedic *Index der Krystallformen*. He had then invented the two-circle goniometer (Figure 4) which he used to measure facial angles in crystals (24), resulting in his compilation *Krystallographische Winkeltabellen*. Bascom had returned to Bryn Mawr with one of the goniometers for her own research.

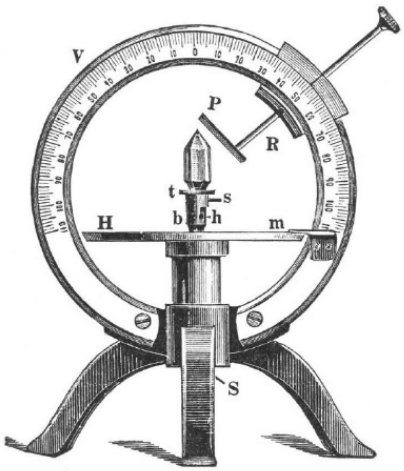

Figure 4*. The Goldschmidt two-circle contact goniometer (24).*

On 14 January 1914, Bascom wrote to Goldschmidt (19):

> I have long had the purpose of writing you to interest you in Miss Porter, who is working this year in my laboratory and whom I hope you will welcome in your laboratory next year. Her heart is set upon the study of crystallography and I hope she will remain with you for more than one year. ... she has never been to school or college save for a very brief period. There are therefore great gaps in her education, particularly in chemistry and mathematics, but to offset this I believe you will find that she has an unusual aptitude for crystal measurement, etc., and certainly an intense love of your subject. I want to see her have the opportunities so long been denied to her−Miss Porter is perhaps about 26 years of age, very modest and unselfassertive but with a quiet initiative. ... She must eventually be self supporting and I hope she will be fitted for the position of curator and crystallographer of some mineral collection.

Goldschmidt did indeed offer Porter a position. She sailed from Philadelphia for Liverpool, England, on the R.M.S. Merion. On 23 May 1914, while at sea off Cape May, Porter wrote to Bascom: "My one ambition in Heidelberg will be to become a less unworthy student of yours." Yet, though Porter and Bascom corresponded periodically into the 1940s, their paths were never to cross again.

While in England, Porter visited Oxford. Ever the academic, she wrote to Bascom on 10 June 1914:

> This morning I went to the University Museum and looked with greater interest at the crystal collection. ... I showed the amethyst crystal to Prof. Bowman ... The rutile crystal, he believes, is a complex twin—but I will write you what the final authority [presumably Prof. Miers] says about it.

Porter added in a postcard of 15 June 1914: "Prof. Bowman admired the pyrite model very much. ... Dr. Tutton and Sir Henry Miers are dining with us Tuesday. Eight people are coming to lunch tomorrow. I would rather face a triclinic crystal!"

Leaving England on the 18th, Porter arrived in Heidelberg on the 20th. On 29 June 1914, Goldschmidt wrote to Bascom with praise for his new student (19): "She started work in the laboratory only two days after her arrival, and her work is outstanding. ... My wife and I are very happy that she is planning to stay here for two whole years."

Porter (Figure 5) had been hoping to at last acquire a formal qualification in Germany, but she discovered that was not feasible. She wrote to Bascom on 19 July 1914 (19):

> It seems quite impossible to get a degree here. Professor Goldschmidt talked it over yesterday with me. You must first have an A.B. or a nine years certificate from a good German *gymnasium*, and then it would be necessary to take three subjects. ... I have been quite depressed, but now that the work is going better, ... I am feeling more cheerful.

Porter was still at Heidelberg at the outbreak of the First World War. She wrote to Bascom on 29 October 1914 (19). In her news, she reported that Goldschmidt had been in a sanitorium for two months—he had taken the outbreak of war very badly and was unable to cope. The laboratory was opened up for Porter alone. Also, she was barred from attending Professor Wulfing's lectures owing to Porter's father having re-taken British citizenship (though Porter herself was an American). She added that she would be "very jealous" [Porter's underline] if there was anyone doing crystallography at Bryn Mawr.

***Figure 5**. Portrait of Porter which she sent to Bascom, undated. (with permission, Sophie Smith Collection, Smith College).*

On 15 November 1914, Porter wrote again to Bascom about the deteriorating situation for her. In addition, she noted that Wulfing had a second reason for barring Porter from his lectures (19):

> The feeling here is now so intense that my mixed nationality [American and British] is a drawback, as it always comes out when I have to fill out papers for change of residence or to audit a University course. ... Prof. W. is also very much against Education for women!

According to Porter's letter to Bascom of 28 February 1915, Goldschmidt was still suffering from severe depression about the War (19). Porter was hoping to stay at the University of Heidelberg for the full two years, but mused about extending her European stay for a third year to take mineralogical courses in Geneva, Switzerland, and Turin, Italy. However, probably in view of the war situation, Goldschmidt argued that she should go immediately during the up-coming two-week University vacation.

Porter did not go immediately. On 4 April 1915, she wrote to Bascom that she was the only student in the Laboratory. Porter had decided to leave for Italy at the end of April taking her precious goniometer with her (19). She had also planned to go to Geneva to work with a professor there in the Fall, but that was not to be.

After travelling to Assisi, Italy, Porter wrote to Bascom on 29 August 1915 (19):

> The professor at Geneva has not yet answered my letter, but he is probably away for the vacation. I shall start for Geneva just the same ... It does seem a great pity not to return to Heidelberg now for the second year as it was planned ... but I cannot face living in a country that is committing such atrocities every day. The moment peace comes I shall, of course, return immediately.

On 12 September 1915, Porter sent Bascom a postcard from Carrara, Italy, where she had visited the world-famous marble quarries (25). In the message, she noted that she was on her way to Paris, not Geneva (19):

> Yesterday I visited the quarries. It took 7½ hours walking all the time but it was most interesting although there is nothing going on at present. I leave tomorrow morning early for Paris. The police sent for me at Massa [where she was staying] this morning to find out why I was here but it was settled satisfactorily. Both places (Massa and Carrara) are in the war zone.

A Return to Oxford

From Paris, Porter travelled to Oxford. Throughout her career, she suffered from ill-health. In early October, Porter had planned to travel to Geneva to undertake research there. However, as she told Bascom in a letter from London of 6 October 1915, her Oxford friends insisted that she saw a doctor urgently (19): "... Dr. Jane Walker (one of the best or the best woman doctor here)." Dr. Walker arranged for Porter to go to her Sanatorium in Suffolk.

On 19 December 1915, Porter wrote to Bascom (19):

> I am feeling much better and am sure that I shall be fit for hard work before long. ... I saw Mr. Barker

> yesterday and he thinks there is some work for me that will be satisfactory, but I am more than sorry that I am not carrying out the work as planned.

Thomas Vipond Barker (26) was the new Lecturer in Crystallography at Oxford. Porter must have commenced research with him, for in a letter to Bascom of 15 January 1916, Porter commented (19): "I began work January 3rd and am consequently in saner frame of mind. ... and am more enthusiastic than ever before." However, it was very lonely in the laboratory as she mentioned in her letter of 28 January 1916 (19): "There is no one in the laboratory here but myself. Mr. Barker is working on dyes in the Chemical Dept & Prof. Bowman on gunsights at Birmingham. The former comes in once or twice a day, however, to see me."

In her letter of 11 February 1916, Porter told Bascom the good news that she thought she could obtain a formal qualification from Oxford University (19):

> Some years ago when I was here, the University was discussing whether they would give B.Sc.'s & B. Litt's to non-members of this or any other University who do research for 2 years (8 terms) and satisfy the examiners on their thesis. Women, of course, get only a certificate but it is probable that after the war, they will be given degrees here—at any rate the certificate is just as good. ...
>
> The work would be on a series of new chemical compounds not described crystallographically. ... If the examination is a failure I would still have finished a good piece of research which would be published in some scientific journal.

Despite Porter's concerns, in a letter dated 15 March 1916, she informed Bascom that indeed a qualification was possible and that Barker was to be her supervisor (19):

> I am sure you will be pleased to know that the University has accepted my application to try for the B.Sc. certificate. Three Board meetings were held in order to discuss it and one called up expressly for that purpose! I am certainly most fortunate. The examination is held in June 1917, and meantime I must write a thesis. The examination is only in crystallography and a small amount of inorganic and organic chemistry. ... Mr. Barker (Lecturer in Crystallography) is the supervisor. If he should be promoted, he said he would like to have me for an assistant, and he has also asked me to write a book on practical crystallography with him.

Porter's health had deteriorated again. In a letter to Bascom of 19 March 1916, she said that she needed two operations, the first being an abdominal one, which would result in (19): "A good deal of pain during the first 48 hours Mrs. Sharlieb says." Mary Ann Sharlieb (née Bird) was a leading surgeon at the London School of Medicine for Women and she had specialized in abdominal surgery (27). Following the operation, Porter wrote to Bascom on 14 April 1916 (19): "Mrs. Sharlieb was operating in me two hours and two other troubles were found—one of which was a poisonous appendix which she says has caused more trouble than anything else." Despite the operation, Porter continued to suffer periods of ill-health, necessitating further major surgery in 1931.

Mrs. Sharlieb said that Porter would require three months of recuperation after the operation. Ignoring Sharlieb's advice, Porter resumed work. She wrote to Bascom on 31 May 1916 (19):

> I am doing two hours work every day and hope to increase that amount soon. I have moved from the University Museum to the School of Chemistry so as to be nearer Dr. Barker who is doing war-work with dyes. The building [the Dyson-Perrins Laboratories] is just finished and perfect for scientific work. I have a large room with windows on three sides (9 in all) and can have it alone as long as the war lasts.

In addition to continuing with her crystallographic studies, Porter was also undertaking wartime research in organic chemistry with William Henry Perkin Jr. (8). Porter mentioned this work in her update to Bascom of 19 November 1916 (19):

> I do practical organic chemistry two days a week, have three lectures in inorganic chemistry and 2 in organic chemistry. The rest of the time is spent on crystallography. Sixteen compounds are finished, excepting the chemical analyses which I shall have to do after Xmas, and have measured over 100 crystals, and drawn about 25, as some of the compounds occur in 2 or more distinct habits.

The research must have proved successful, for on 9 June 1918, Porter wrote to Bascom that her thesis examination had been on June 1st and that it had gone well. Bascom had always expected Porter to return to take up a position at Bryn Mawr once her studies were completed. However, as Porter made clear in her response, this was not how she saw her future (19): "You make me turn pale at the mention of a 'chair of crystallography.' The bare idea makes me turn *cold*. The ambition of my life is a research fellowship, or scholarship−or museum work." Porter added that she had already had an offer of rearranging a gem collection in a national museum but had to refuse as her thesis needed reworking to add more chemical content.

In a letter to Bascom of 24 June 1918, Porter shared the news that she had received her B.Sc. Certificate (though not a formal degree) (19):

> My "certificate in science" has just come and I have it actually in one hand, so there is no more doubt about it!!! ... I have my first pupil in crystallography, the friend who is living with me, a Cambridge graduate, who is an assistant in the Bodleian Library. She is working quite seriously at it, and is going to measure a crystal on the reflecting goniometer this week. ... She is teaching me mathematics in return!!

Porter was keen to pass on the techniques which she had developed for crystal drawing. On 26 January 1919, she wrote to Bascom (19): "I might write a short article along the lines of the headings I am enclosing on a separate slip−if you thought it worthwhile." This article on practical crystal drawing was published in 1920 (28).

Professional Acceptance

In Britain, admission of women to professional scientific societies provided challenges. We have documented elsewhere the fights for admission of British women chemists to professional organizations (29). For Porter, the appropriate professional body was the Mineralogical Society of Great Britain and Ireland, founded in 1876. This organization did not seem at all hostile to women mineralogists. For example, in 1894, at a General Meeting of the Society, one of the invited Visitors was a Miss Walter, who "exhibited a new form of goniometer" (30).

The first woman elected as an Ordinary Member of the Mineralogical Society had been Catherine Alice Raisin, D.Sc. in 1908 (31). Raisin was a pioneering and well-known professional geologist (32). Two years later, Porter became the second woman elected as an Ordinary Member (33).

Though Raisin had paved the way to women's Membership in the Society, it was Porter who made the greater breakthrough. Porter conveyed the news to Bascom at the end of a letter she wrote on 12 August 1918 (19):

> Did I write you that I had been nominated for election to the Council of the Mineralogical Society? There was a great row about having a WOMAN on it but the majority agreed in the end. I have accepted, so expect to be elected at the next meeting. We [women] are getting in, however, and the Mathematical Society has also elected a woman to serve on the Council ...

However, the excerpt of the Minutes of the Council Meeting make no reference to any discussions accompanying Porter's election to Ordinary Member of Council (34). She held the position from 1918 to 1921 and again from 1929 to 1932. In addition, Porter was elected Fellow of the Mineralogical Society of America in 1921, from which she resigned in 1927.

A Long-Term Future at Oxford

Like so many of the single women researchers, money was always a concern for Porter. She noted in her letter of 12 August 1918 to Bascom that her financial situation had just improved. Her annual income had been only £46 per year together with some help from her brother. The Department of Industrial and Scientific Research had just awarded her a grant of £150 for one year's research work.

Finally, Porter secured a longer-term appointment, that of the Lady Carlisle Research Fellowship as she wrote to Bascom on 8 May 1919 (19):

> There are only two fellowships in Oxford and I have been elected to one−the better of the two. It is the Lady Carlisle Research Fellowship for five years at Somerville College. This brings with it £120 per year and is the best fellowship in the country for women. ... The fellowship begins next October and I shall dine in college every night but remain in this small house, which I have taken for five years. It is very close to the museum and has a small garden. The friend who was with me in the flat has joined me here, which makes it very pleasant.

This Fellowship provided Porter with financial security and—equally important—prestige for someone with limited academic background. The Fellowship derived from a gift to Somerville College of £3000 by Rosalind Frances Howard (née Stanley), Countess of Carlisle (35). Howard was known as the "Radical Countess" for her left-wing views and support of total women's suffrage, thus the cause of women's higher education clearly appealed to her. The conditions of the Award noted (36): "The Fellow will be elected by the Council, with or without special examination, with a view to research or the pursuit of learning in one or more of the following subjects: ... Natural Science ..." In the applications, the candidate was expected to (36): "state their University distinctions (if any)."

The application had been submitted on Porter's behalf by Professor H. R. Bowman, who had supervised some of Porter's crystallographic research (37). He attached supporting letters provided by Tutton (38); Miers (by then vice-Chancellor, University of Manchester) (39);

and Sir William Osler, Regius Professor of Medicine at Oxford (this letter has not survived). Despite Porter's minimal academic qualifications, it is unlikely any other candidate could have marshalled such a prestigious set of testimonials. That of Miers, in particular, is worth quoting in part (39):

> Throughout the whole of her career, Miss Porter has shewn herself to be imbued with the spirit of scientific research, she has become an expert on many branches of mineralogical investigation, and the College may feel sure that she will carry through with determination any piece of work to which she sets her hand. She appears to me to possess precisely the characteristics which will enable her to bring credit to the College, if she is elected to this Fellowship.

One of the conditions of the Fellowship was that the recipient was expected to give public lectures. Porter sent Bascom a news update on 28 February 1920 (19):

> I gave my first lecture on crystals—Feb. 19—before the women's scientific club here and suffered much anguish! It was on "the Occurence and Personal Habits of Crystals" and have to prepare two for next term ... I have been much better in health this winter, especially since xmas, and think that I am much stronger.

With Oxford University finally awarding formal degrees to women, Porter received her degree at Congregation as she described in a 8 November 1920 letter to Bascom (19). (The work Porter cited was published jointly under the names of Barker and Porter (40).)

> On Oct. 14 I got my B.Sc. degree with the first 50 women to receive degrees at this University. I was the only B.Sc. and it was an ordeal as the Sheldonian was packed with people—about 2 or 3000—and I had a little ceremony all to myself. ... We have just finished off a big piece of work and it has come out in the transactions of the Chemical Society (Oct. 1920). I did all the practical work and Mr. Barker wrote the chemical introduction and helped me throughout with advice.

In Porter's letter to Bascom of 12 October 1921, she mentioned she had an article published (41), though she was worried about the progress of her research (19):

> My research gets on slowly and I get very much discouraged some times as new obstacles turn up. However, I have a short paper in the next Chemical Journal which I was asked to read on Oct. 7th in London. I did not need to read it & haven't the courage!

It was on 3 May 1923 that Barker wrote to the Somerville Council, requesting Porter be re-elected for a second tenure of the Fellowship (42). He described how Porter's research was proceeding slower than anticipated due to unexpected complications in the project. He argued that Porter had unique talents for the work and that the work itself was of great scientific importance (42):

> She has a real ability for this kind of work, combined with an intense enthusiasm with an unsurpassed delicacy of manipulation and the patience necessary for refined work of precision. Moreover, the actual results are bound to be of great value, especially to the science of mineralogy ...

The extension of the Fellowship to 1927 was approved. The research was a study of the optical properties of mixed cation crystals; specifically, ammonium magnesium sulfate, ammonium magnesium chromate, and rubidium magnesium chromate. The results comprised a 20-page research paper published in 1925 in the *Proceedings of the Royal Society*, the sole author being: "Mary W. Porter, B.Sc. (Oxon.), Lady Carlisle Research Fellow, Somerville College, Oxford and communicated by Sir Henry A. Miers, F.R.S." (43).

In fact, Porter held the Fellowship until 1929. With its expiry, she had to live on income from rental property which she owned, a small inheritance from her father, plus a few minor research grants. During this period, she continued with her comprehensive studies of the crystal and optical properties of series of ionic compounds, the work being published in three lengthy contributions to the *Zeitschrift für Kristallographie* (44). As a result of her research, Porter was awarded a D.Sc. degree in 1932 as she described in her letter to Bascom of 27 June 1932 (19):

> The degree I took in 1921 was the B.Sc. There are three research degrees given here. The B.Sc. comes first, and then the D. Phil. ... The third is the D. Sc. and for this there is no examination. You receive a hint that you may send in your publications and supplicate for the degree. Then two judges are appointed who examine the work and report to the Board of your special faculty. ... I took the degree last Thursday and now have a lovely scarlet and grey gown!

It was crystallo-chemical analysis which became Porter's obsession, that is, determining the chemical composition of a crystal by means of crystal classification and precise measurements of crystal faces. Porter co-authored a later article in *Nature* which extolled the benefits of crystallo-chemical analysis (45):

> Every chemist is familiar with the well-developed crystals bounded by plane faces which are formed by chemical substances. That the angles between these faces are characteristic of the substance and can be

> measured accurately by the reflecting goniometer is common knowledge.

Clearly it would be of advantage to the chemist were he able to make practical use of these characteristic angles for purposes of identification, as an alternative to the ordinary methods of analysis. Only a very small amount of material would be required, for a crystal of the size of one cubic millimetre, or even less, can be accurately measured. Moreover, when the measurement is completed, the crystal remains intact.

Porter had undertaken research in 1924 which used crystallo-chemical analysis for precisely this purpose. She had been given some tiny crystals (about 1 mm by 3 mm) which had been found in an individual's lungs and asked to determine the chemical composition. Porter identified the crystal faces (Figure 6) and recorded the facial angles. By comparison, Barker showed the faces and angles to be identical to those of the mineral struvite, $NH_4MgPO_4 \cdot 6H_2O$. In the subsequent publication, Porter noted that (46): "A chemical test was subsequently carried out by Miss. E. Ewbank (The Chemical Laboratories, Oxford) and this agreed with the above determination." (Elinor Ewbank was a researcher in the Dyson-Perrins Laboratory, Oxford, from 1922 until about 1930 (47)).

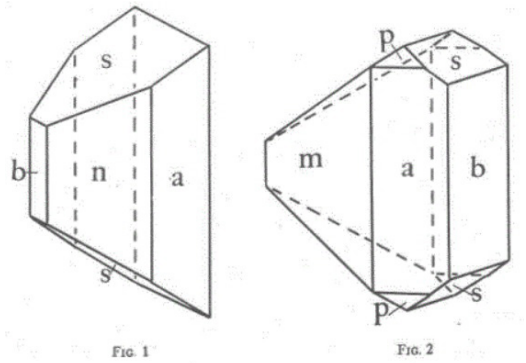

***Figure 6**. Porter's diagram of the crystal faces of crystals found in an individual's lungs (46).*

In a letter to Bascom of 7 January 1938, Porter reported on a test of the crystallo-chemical analysis method (19):

> Prof. Bennett (Chemistry, Sheffield) offered to give us a test, so we sent him a list of some 1200 compounds now in the card index. He chose 16 from the list and had the compounds prepared in his laboratory. These were sent to us numbered and unnamed. I measured them and identified them all by their angles in the Index. ... All the substances were correctly identified without recourse to chemical analysis.

The Barker Crystallographic Index

Porter's later life-work came to revolve around the completion of the *Barker Crystallographic Index* which was intended to provide a comprehensive database for the chemical identification of crystals. It was the Russian scientist, Evgraf Federov at the University of St. Petersburg who had pioneered the concept of crystallo-chemical analysis (48). Miers had sent Barker to St. Petersburg in 1908 to learn the methodology which utilized Federov's own design of a microscope with a goniometer stage (49). Federov died before completing his mammoth research on crystal structures and chemical composition.

Upon his return to Oxford later in 1909, Barker's goal was to compile a morphological index of crystals corresponding to their chemical composition. To aid him, he enlisted Porter and Reginald Charles Spiller. Porter had been trained on Goldschmidt's more sophisticated goniometer and in her letter to Bascom of 15 January 1916, she made clear her belief in its superiority over Federov's (19):

> I used the Federov two-circle goniometer (much cheaper and not nearly as good as Goldschmidt's) and made stereographic projections on nets like the one enclosed. ... Mr. Barker and I have many heated arguments as to the respective merits of Federov and Goldschmidt but neither of us succeeds in converting the other.

Subsequently Porter was successful in her proselytizing, as she communicated to Bascom on 11 February 1916 (19): "I have made a convert of Mr. Barker I think, and have taught him to make a gnomic projection and drawing according to Goldschmidt. He is particularly pleased with the latter."

It was Barker's invitation to work with him on the *Index* which was to change Porter's future. Porter provided details in her letter to Bascom of 15 March 1916 (19):

> If he [Barker] should be promoted, he said he would like to have me for an assistant, and has also asked me to write a book on practical crystallography with him. The Goldschmidt methods would be described in it as also the stereographic methods. However, this all seems too much in the future. My only regret is that there is no Goldschmidt goniometer here−the Federov one is horrid!

Porter felt strongly that crystallo-chemical analysis had been ignored by chemists. She expressed her frustration in her letter to Bascom of 26 January 1919 (19):

> What makes me more angry than anything is that *so called* scientific men will not *take the trouble*

> to investigate the Goldschmidt methods. Of the crystallographers in England I do not believe more than two can use a two-circle goniometer or have *ever* tried one!

Finally, Porter was able to obtain her own Goldschmidt goniometer. She wrote excitedly to Bascom on 28 February 1920 (19):

> I know that you will be pleased to hear that after fighting "tooth and nail" I have succeeded in ordering a two-circle goniometer—the first to come to England! The price is now £75 ... and Professor Goldschmidt wrote me it would be increased by 50% or more by the end of the year. So I felt it was *now* or *never*. Somerville College is buying the instrument out of the Carlisle Research Fund and it is to be for my use for the next five years. Then I can have the option of buying it for myself, which I shall be able to do then. I am delighted beyond words, as you can imagine how discouraging it is to work with a bad instrument.

Barker died in 1931. However, Porter and Spiller continued on with the work, it being noted in the history of the Department that (8): "The thousands of trigonometric calculations and goniometric measurements required represent an enormous volume of work, shared with a small team of enthusiasts in this country, the United States and, notably, in the Netherlands."

The announcement that work on the *Index* was almost complete was given at a Meeting of the X-Ray Analysis Group of the Institute of Physics, held in Birmingham in 1945 (50). The first volume, co-authored by Porter and Spiller, *A Method for the Identification of Crystalline Substances, Vol 1: Crystals of the Tetragonal, Hexagonal, Trigonal and Orthorhombic Systems* (51), appeared to acclaim in 1951 (52).

Though Spiller had died two years earlier, the second volume, *Crystals of the Monoclinic System*, was published in 1956, with Porter and Spiller as co-authors (53). This compilation, too, received a very positive review (54). For the third volume, *Crystals of the Anorthic [Triclinic] System*, Porter acquired a new co-author, L. W. Codd (55). As a reviewer noted, the three volumes together contained crystallographic data on a total of 7,300 crystalline substances (56). Codd subsequently authored a paper on the *Barker Index* as an analytical tool. However, nowhere in the article did Codd mention Porter's name or contributions (57).

The discussion of the work at Oxford on classical crystallography by Miers, Barker, and Porter provides a thread through the account: *Geology and Mineralogy at Oxford 1860-1986: History and Reminiscence* (8). As to the production of volume 3, following Spiller's death, it is noted that (8):

> ... it is entirely characteristic of Miss Porter that when, after Spiller's death in 1954, she tackled the triclinic (or, in Oxford parlance, anorthic) system practically single-handed at the age of seventy or so, she learned to use the University's first digital computers, realising that she could probably never complete her task otherwise.

Porter continued to proselytize for the crystallochemical method of chemical analysis. In an article in the review journal *Endeavour*, Porter claimed that the publication of the first volume of the Index was (58): "an outstanding event in the history of chemical analysis." The author of the book *Geology and Mineralogy at Oxford 1860-1986* disagreed. He summed up this heroic work as an avenue of research whose time barely came before it went (8):

> The preparation of the *Barker Index* constituted a major part of the research work of the Department of Mineralogy for many years. Remarkable document though it undoubtedly is, the fact cannot be disguised that its practical value has been very limited, due to the rapid development since the late 1920s of X-ray diffraction methods in crystallographic analysis, which generally provide quicker and more reliable results, as well as requiring less specialised experimental skills on the part of the investigator. The *Index* is very much part of the Oxford Department's history, however, with meticulously detailed work devoted to a cause which, to many must have seemed lost almost from the outset.

Porter's Later Life

During the Second World War, Porter took on war duties as she described in a letter to Bascom of 14 January 1940 (19): "I drive First Aid Nurses from their homes to their Post five nights a week between 9.30 p.m. and 10.30 and some mornings at 8 a.m. as well."

Though she had dedicated most of her later life to the work on the *Barker Index*, Porter's last co-authored research was appropriately with Hodgkin. The publication was the Appendix to a study on the crystals of the anti-pernicious anaemia factor (vitamin B_{12}) in which Porter reported the crystallographic measurements (59).

A Member of the Somerville Council from 1937 until 1947, Porter was then appointed Honorary Research Fellow in 1948. Porter's last work came full circle back to that on the Corsi marble collection. In the history

of the Corsi collection, her later contributions were described (6):

> She [Porter] gave instructions for the labelling of decorative stones in some of the older petrological collections of the Museum, and she reviewed the display of the Corsi collection. It was decided that a new case would be built, designed to store the slabs in pull-out racking that would make them readily accessible under the good light of the Museum's glass-roofed courtyard. A selection of samples would be displayed in glass cabinets on three sides of the new case. ... She [Porter] illustrated her displays with photographs of the stones used in monuments and statuary, and with samples of Egyptian 'alabastri' and cosmati pavement.

Nothing could be found on the last years of Porter's life. She died on 25 November 1980 in Oxford, age 94.

Porter's Contributions in Context

Maureen Julian was the first to report upon the concentration of women in the field of X-ray crystallography (60). The subject has also been addressed by Ferry (61), Franci (62), and Kahr (63). In our account of early British women chemists, one specific focus was that of the pioneering British women X-ray crystallographers (64).

Porter's life-story was incredible, commencing with a lack of formal education and concluding with a B.Sc., a D.Sc., and an Honorary Research Fellowship. Yet how does her work fit in with the narrative of women's roles in British X-ray crystallography?

Franci has proposed that Porter played the key role in opening British X-ray crystallography to women (62):

> I suggest that Bascom at Bryn Mawr and Porter at Somerville were the seeds from which the large crop of women in X-ray crystallography sprouted. Women were not being escorted into a new field by kindly men such as the Braggs, as much as they were seeking out exciting opportunities within a field they already inhabited.

However, this conclusion seems oversimplified. It confuses classical crystallography, which Porter tried to use to determine chemical formulas, with that of X-ray crystallography, whose purpose was to determine the atomic/ionic structure of compounds. It is certainly true that understanding the crystal shapes and faces—and the use of goniometers—was a prerequisite for the use of X-ray analysis; however, the goal was quite different.

In tracing the "genealogy," in our opinion, Bascom was not a central figure in the crystallography "family tree:" Bascom was a mineralogist and geologist. In contradiction to Franci, it was indeed a "kindly man"—in Porter's case, Henry Miers—who took an uneducated young woman with a fascination for marble, and enabled her to find her life work in the field of classical crystallography.

There are on-line claims that Porter was, in fact, a pioneer X-ray crystallography. This notion is incorrect. All of Porter's publications dealt with identifying crystal faces and measuring facial angles as a means of compound identification. Nevertheless, Porter has a strong claim to being the starting-point of the lineage of X-ray women crystallographers. In Ferry's biography of Hodgkin, Ferry comments (65): "She [Porter] also assisted with teaching a practical class in crystallography for undergraduate chemists. Dorothy [Hodgkin] came to know her through these classes and her Somerville connection, and found her 'a great encouragement'."

In 1931, Hodgkin had visited Germany, in part to improve her German as the leading crystallography journal of the time was *Zeitschrift für Kristallographie*, and in part to improve her crystallography skills by working with Goldschmidt. It was Porter who provided Hodgkin with an introduction to Goldschmidt. Before Hodgkin left Oxford for Heidelberg to learn Goldschmidt's crystallographic techniques, Porter had warned her (66): "... not to talk [to Goldschmidt] about working on X-ray diffraction because [he] only likes the outside of crystals."

Finally, it is of specific note that Hodgkin involved Porter in the 1950 joint publication on the morphological properties of a crystal of vitamin B_{12} (59). We are convinced Hodgkin did so, not out of any sense of loyalty, but because Porter was the most respected expert on classical crystallography.

In conclusion, Porter's own work in later years, sadly, proved to be a backwater of crystallographic science. Nevertheless, her life-story is inspiring in the extreme. In her youth, she was prevented from having an education, while in her later life, she had extreme privilege in her interactions at Oxford University. It is our contention that, yes, indeed, she was the first of the pioneering women in this field and an inspiration to Hodgkin, future Nobel Laureate.

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entire collection of correspondence from Mary Porter to Florence Bascom.

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EuChemS Heritage and History of Chemistry Symposium

The Working Party on the History of Chemistry (WPHC) of the European Chemical Society (EuChemS) held an online symposium on Heritage and History of Chemistry on May 20, 2021. Organized and chaired by Ernst Homburg (Maastricht University) and Ignacio Suay-Matallana (Interuniversity Institute López Piñero-UMH), the online symposium was held during time when the 13th International Conference on the History of Chemistry had been scheduled. The 13th ICHC has been rescheduled for May 2023 in Vilnius, Lithuania.

Two sets of short presentations were given. The first, titled Chemical Landmark Projects and Heritage Initiatives, included an opening lecture on the recently established EuChemS Historical Landmarks program by Brigitte Van Tiggelen, former chair of the WPHC. The remaining presentations discussed national projects in Japan (the Chemical Heritage Japan program of the Chemical Society of Japan), France (work in progress on the heritage of industrial chemistry), the US (the ACS National Historic Chemical Landmarks and the HIST Citation for Chemical Breakthrough programs), and Germany (the Historische Stätten der Chemie program of the Gesellschaft Deutscher Chemiker). The second set, titled Chemical Sites, Collections and Preservation presented collections in France (Association de Sauvegarde et d'Étude des Instruments Scientifiques et Techniques de l'Enseignement), Italy (the chemistry collections at the Natural History Museum of the Università degli Studi, Firenze), Russia (equipment of Nikolay Zelinsky at the Polytechnical Museum of Moscow), Denmark (samples of coordination compounds of Sophus Mads Jørgensen at the Technical University of Denmark), Latvia (the Latvian Museum of the History of Chemistry at the Riga Polytechnic Institute), and Portugal (instruments for the teaching of chemistry in secondary schools throughout Portugal).

A recording of the event is available at www.euchems.eu/divisions/history-of-chemistry-2/conferences/