DR BARBARA S. NEUMANN: CLAY SCIENTIST, INDUSTRIAL PIONEER, CREATOR OF LAPONITE®

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Dr Barbara Zsusanna (Susanna) Neumann was the inventor of the extraordinary product known as Laponite®, which is a synthetic hectorite clay. The range of Laponite® products, developed in the UK during the early 1960s, is one of the first examples of truly nano-dimensional materials manufactured on an industrial scale at the time when the field of nanotechnology was only being hinted at (Feynman 1960). These hectorite-like synthetic nano-clays with very unusual properties have been an enduring commercial success for the UK company that first patented and introduced them to the market, Laporte Industries, and which is now a part of the BYK company.

Barbara Neumann was passionate about clay science and mineralogy and was determined to succeed on an industrial scale. Few are aware of her journey from wartime Hungary to Redhill in Surrey (England) and her determination to succeed in what was largely a man's world. A number of momentous turns of fate led to the discovery of Laponite® and other industrial minerals, still produced in thousands of tonnes and utilized around the world today.

Figure 1 Barbara Neumann at the Fuller's Earth Union (FEU) research laboratory. The FEU later became part of Laporte Industries in the 1960s, which itself later became part of the BYK company.

Long-time friend and colleague Christopher Jeans takes up the tale:

Christopher Jeans: "Barbara began her life in England and her job at the Fuller's Earth Union (FEU) in 1939 (Fig. 1) at a time of commercial flux for a long-established industry based on Ca-montmorillonitic earths. The earths were known only from a few localities, and they were being used up much faster than new deposits were being discovered."

Barbara Neumann (née Beer) was born in November 1914 and her first vivid memory was fleeing, at the age of 2 or 3 years, with her family from Szolnok, central Hungary, during the First World War. She and her family had to move to Budapest (Hungary) to live with her grandmother. She later attended University – a significant achievement for a Jew in the Hungary of that time – to study physics. Significant pressure was brought to bear on Barbara to give up her studies, but she persevered (with the support of a generous uncle) and achieved a degree and then a PhD in physics.

In what she described as a major stroke of luck, one of the samples of clay she had been working on as part of her PhD research (X-ray diffraction of clays) was a fuller's earth, with the address of the supplier on the packaging: Fuller's Earth Union, Redhill, Surrey. Barbara then showed her determination by writing to the manufacturers, saying that she thought she could improve their product and .... would they, therefore, give her a job? She was 25 years old when she first visited England for the interview.

Barbara travelled to England alone, knowing little English. She often spoke to her family about how welcoming people were in England. Shortly afterwards, in the immediate aftermath of the war, she met and married her second husband, Franz Neumann, who had also arrived in England as a refugee fleeing from Austria. They had two children, Vera and Peter. Barbara continued to work full-time at Fuller's Earth Union, which later became part of Laporte Industries. Her daughter, Vera, later began to appreciate how unusual this situation was. Working mothers were a rarity in the 1950s; moreover, very few of them would have worked in a research laboratory. Nonetheless, Barbara strongly believed in women's self-sufficiency and independence, and certainly practised it. Vera notes that Barbara was proud and amused when the chair at a scientific meeting addressed the audience as "Lady and Gentlemen".

Christopher Jeans: "For a creative physicist, such as Barbara, it was one thing to improve a natural product as much as possible, but quite another to design and tailor an ideal material for a specific task. She must have had this ambition in the front of her mind, just waiting for the chance to put it into practice, once the pressure of war work was over."

In the late 1950s and the early 1960s, Laporte Industries were a major manufacturer of titanium dioxide pigments for paints. The most common paint systems at the time were organic solvent-based. Organically modified natural clays, such as bentonites and hectorite, were increasingly offered as thickeners for these paints. On the other hand, a new type of safer, and more environmentally friendly, water-borne emulsion coatings and paints was coming to the fore in various industries (Croll 2007). In order to accommodate titanium dioxide and other pigments in these new formulations, Laporte Industries tasked their research unit in Redhill with finding the right additives to provide better rheology (fluid flow) in these systems. Barbara Neumann was one of the leading members of that team. Initially, a number of different inorganic minerals was tried – natural clays, synthetic hydrotalcites, and so on. However, they either required significant amounts of the additive in the formulation or they imparted poor optical properties to the coatings due to the low intrinsic transparency of these materials.

Neumann began by testing a method proposed in a seminal paper by Geanquist and Pollack (1959). She soon realised that this route to synthesis was not industrially feasible and set about creating one that was. After several iterations, the first Laponite® material was born. In the corresponding filed patent, the synthesis, including starting materials and conditions, had been completely reworked and optimised for production on an industrial scale (Neumann 1962).

Barbara worked hard to introduce Laponite® synthetic clays to a wider industrial and scientific audience, including specialists in products for the oil and gas industry, paints and coatings experts, as well as scientists working in the broader area of rheology and formulation science. Her presentation at the Joint Meeting of the British Society of Rheology and the Research Association of British Paint, Colour and Varnish manufacturers on the 29 April 1964 is believed to be the official 'Birthday' and the beginning of the commercial success story of the Laponite® brand.

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Today, the manufacture of Laponite® retains significant similarities to the synthesis route originally proposed by Neumann (FIG. 2), despite becoming a modern chemical production with state-of-the-art engineering and highly automated process control.

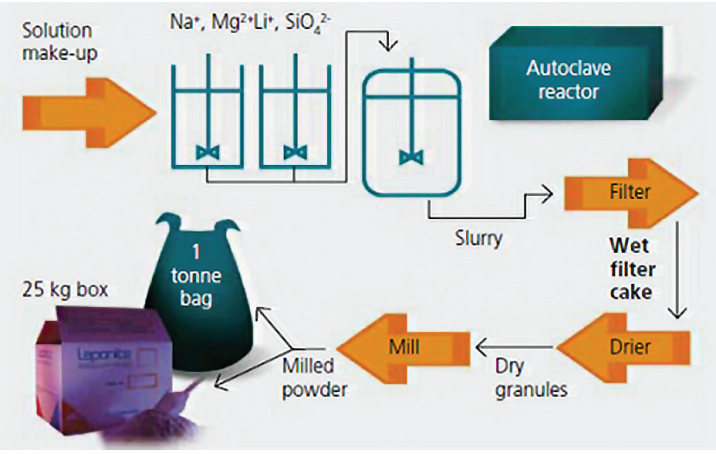

FIGURE 2 Schematic flowchart depicting the general process for making Laponite®. BYK Additives and Instruments

CONTRIBUTIONS TO THE CLAY MINERALS GROUP OF THE MINERALOGICAL SOCIETY OF GREAT BRITAIN AND IRELAND

Barbara was also a very active and enthusiastic member of the Clay Minerals Group (CMG) of the Mineralogical Society of Great Britain and Ireland and served as its first female Chair from 1967 to 1969.

Through the CMG, Barbara developed an interest (in common with fellow CMG member, Christopher Jeans) in the origin of Ca-montmorillonite in the British Mesozoic strata that formed the basis of the UK's fuller's earth industry:

Christopher Jeans: "The origins of the English fuller's earths were contested energetically. Were they marine chemical precipitates or derived from the breakdown of volcanic ash? For Laporte Industries, their origin was an important matter. The earths were stratigraphically very restricted to marine sediments of Aptian (~112 Ma) and Bathonian (~165 Ma) age and they were fast running out. What was the commercial future of an industry based on a natural, but variable, product that could not be replaced?"

A detailed history of fuller's earth was written by Robert Robertson in 1986 (FIG. 3). Robert was a founder member of the CMG, and partial funding for the project came from Laporte Industries.

After five decades of success, the Laponite® synthetic mineral invented by Barbara has undergone a renaissance. New application opportunities have opened for this material in biomedicine, catalysis, nano-imaging, energy storage (Li batteries), clay–polymer nanocomposites, advanced coatings and films. Scientists continue to invent new uses for Laponite®, as well as using it as a model clay system to advance understanding of complex clay behaviour in aqueous suspensions and other colloidal systems.

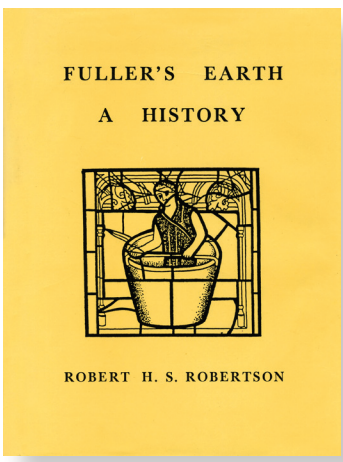

FIGURE 3 The front cover of Fuller's Earth: A History of Calcium Montmorillonite (1986, Mineralogical Society Occasional Publication, Volturner Press) by Robert H. S. Robertson.

This success story would not have been possible without Barbara Neumann. Many industries and researchers use Laponite® today, and the wider clay science community are deeply indebted to this talented industrial scientist for the work and discoveries she made.

Two important books about the history of clays published in recent decades both failed to mention Barbara Neumann, a fact pointed out in a review of both by Jeans (2009). So, it is appropriate that the Mineralogical Society, the Clay Minerals Group, and BYK have undertaken to remember Barbara now through this publication.

FIGURE 4 Barbara Neumann around the time of her retirement, aged 60.

In her honour, the Mineralogical Society has decided to retitle its senior medal in her name (https://www.minersoc.org/neumann.html). The first medal will be awarded in 2022.

Barbara retired at 60, as she had planned (FIG. 4). She remained very active and took on some consultancy work. She also joined and/or organised numerous classes, including geology, Spanish, English literature, and philosophy. Following a stroke, Barbara died in 2002, in her 88th year.

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