REMEMBRANCE OF CARBONATITES PAST

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As I was finishing my PhD thesis on the Borralan alkaline complex in Scotland, my professor, Basil King, who published the first account of the Napak carbonatite occurrence in Uganda, proposed that I should apply for a NERC fellowship to investigate the fenites associated with carbonatites of the Chilwa Province in Malawi (FIG. 1). After a successful application, I duly flew out to Malawi and spent three months building an extensive collection of fenites from the very large metasomatic aureoles around the carbonatites of Chilwa Island, Tundulu, and Kangankunde. Back at Bedford College (University of London, UK) I had been working on my fenites for about a year when Brian Sturt, a lecturer in the department, told me that at a council meeting of the Mineralogical Society of Great Britain and Ireland the previous day he had been told by Frank Claringbull that he, Claringbull, was looking for a petrologist to work in the Department of Mineralogy at the British Museum (Natural History), now called the Natural History Museum. I arranged to see Claringbull, was interviewed, and was fortunate enough to be appointed as a petrologist in the department.

FIGURE 1 Chilwa Island (Malawi). The central, flat-topped plug is of carbonatite; the outer slopes are of fenitized basement rocks. Picture taken in 1966.

I continued my fenite work at the museum. From time to time, Dr Campbell Smith, a previous Head of the Department of Mineralogy but then retired, came in to see how my Chilwa work was progressing. In conversation we occasionally discussed the bulletin on the Chilwa Province that he, F. Dixey, and C.B. Bissett had published in 1937. The story behind that bulletin seems to be little known, but it played an extraordinarily important part in the carbonatite story. In the 1920s and 1930s, Frank Dixey was the Director and sole geologist on the Malawi (then Nyasaland) Geological Survey and he had few facilities for research. So, he arranged to send to Campbell Smith geological specimens on which Smith would report on the petrography, mineralogy, and chemistry. The crucial part of this cooperation is evident from the letters they exchanged, which I have had bound into a small volume and had placed in the museum's library. I give brief excerpts from these letters below.

11 December 1933. W.C. Smith to F. Dixey.

> *"You will perhaps be surprised at the guesses I am hazarding, but I believe we shall find they come fairly near the truth.*
>
> *During my work on these rocks, I have been frequently struck by rather vague but suggestive resemblances between your rocks and some of those described by Brøgger from the Fen district of Norway, with which you may be familiar. Briefly, the alkaline rocks of the Fen district consist of intrusions of ijolite and related rocks, associated with limestones of magmatic origin, intruded into biotite-granite of the district. Remarkable rock types, of which fenite is the most important, have been formed at the margin of the biotite-granite owing to its impregnation by material proceeding from the intrusive nepheline-rich rocks.*
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> *I ... am satisfied that we can use Brøgger's explanation of events in that region as a working hypothesis on which to interpret the Lake Chilwa rocks....*
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> *Can you explain your crystalline limestones as 'intrusive'? Are they connected at all with definitely metamorphosed sedimentary limestones?... It is important to get this right because of its bearing on Daly's theory of the origin of alkali-rocks. In Uganda, Davies has been working on the limestones and associated rocks of Tororo Hill and I gather that he assumes it to be metamorphosed sediment, but it may not be so."*

11 January 1934. F. Dixey to W.C. Smith.

> *"The limestone. I find it hard to believe that the main mass of limestone is other than of sedimentary origin, although of course carbonate rocks may possibly have been intruded as part of the episode. The Tundulu limestone is one of three occurrences of similar limestone in this region, ... The Muambe and Chilwa Is. limestones are flat-lying masses of sedimentary character, and Tundulu ... has every appearance of being a mass of the same limestone which has become involved in the igneous complex. As an additional point all three occurrences contain somewhat similar iron-manganese rocks, of which I send you some specimens...."*

25 October 1934. F. Dixey to W.C. Smith.

> *"With further reference to our correspondence on the Chilwa rocks, you will be interested to know that I have just spent three weeks on the area, keeping the various doubtful points in view...*
>
> *The limestone of Chilwa Island is not a flat-lying limestone sedimentary formation, but a great peneplained plug of intrusive limestone intimately associated with feldspathic intrusive and intrusive breccias, all cutting the ancient schists and gneisses, and invaded as elsewhere, by nepheline syenite.*
>
> *Tundulu is similar, ... I saw several dykes of limestone and feldspathic rock of precisely the same character as in the larger vents...."*

3 December 1934. F. Dixey to W.C. Smith.

> *"You will be glad to know that your examination, combined with observations of the last few weeks, leads quite definitely to the conclusion that my 'Chilwa syenites'* [fenites] *belong to the basement complex and have been altered to a greater or less extent by 'vent' magmas. This confirms your earlier suggestions and brings the series very closely into line with that of Brøgger's...."*

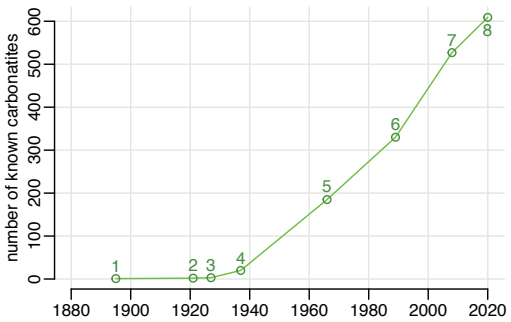

Figure 2 Graph of the number of carbonatites known against year. The numbered data points correspond to the following published sources. 1. Högbom (1895); 2. Brøgger (1921); 3. Soellner (1927); 4. Dixey et al. (1937); 5. Gittins (1966); 6. Woolley (1989); 7. Woolley and Kjarsgaard (2008); 8. Humphreys-Williams and Zahirovic (2021 this issue).

It is important to note that, at that time, knowledge of, and belief in, carbonatites was very limited. The extraordinarily detailed monographs of Högbom (1895) and Brøgger (1921) on Fen and Alnö (Sweden), both written in German, were not widely known, and these occurrences, plus Kaiserstuhl (Germany), were the only carbonatites that had been recognised and described in detail. There were also many in the petrological community who would not accept that igneous limestones could exist, believing that they must involve, in some way, mobilisation of sedimentary limestone. I encountered this side of the argument when I gave a lecture to colleagues at the Natural History Museum in the 1960s, at the end of which my boss at the time said that I must be wrong as experimental evidence indicated that limestones could not be molten at reasonably acceptable temperatures. This background, to my eyes, makes it all the more remarkable that Campbell Smith, sitting in London, committed himself to believing that many of Dixey's Chilwa rocks were carbonatites and fenites.

Figure 3 Oldoinyo Lengai Volcano (Tanzania) blanketed by natrocarbonatitic ash which, being hygroscopic, has reacted with the atmosphere. The photograph, taken during the 1960s, was given to me by a tourist.

When the Dixey et al. (1937) bulletin was published it described 11 occurrences of carbonatite and associated fenites in the Chilwa province and, even more remarkably, Campbell Smith suggested that limestones associated with igneous rocks at Kalkfeld and Okorusu (Namibia), Palabora (South Africa), Lokupoi (Napak), Toror and Tororo (Uganda) might be similar and of magmatic origin. He was right in every case and had increased the known number of carbonatites from 3 to 20. After World War II, that number increased rapidly again and has continued to do so until the present day, as illustrated in Figure 2. The known number is now 609 (Humphreys-Williams and Zahirovic 2021 this issue). Acceptance of carbonatites as igneous rocks was given a timely boost in the 1960s by the activity of the Oldoinyo Lengai Volcano at which extrusive carbonatite was recognised for the first time. A photograph of the volcano at that time is shown here (Fig. 3). And no, it is not covered in snow but by natrocarbonatitic ash which, being hygroscopic, has reacted with the atmosphere.

It was always a delight when Campbell Smith popped in to find out how the fenite and carbonatite work was progressing. At a small party given in Campbell's honour on his 80th birthday, a telegram was received from Dixey, who was then also about 80, apologising for not being able to attend because he was on field work in Cyprus. Campbell Smith reached the grand old age of 101 and a more charming gentleman I have never met.

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AUTHOR BIOGRAPHY

Alan R. Woolley obtained his BSc from the University of Liverpool (UK), contemporaneously with the Beatles rocking at the Cavern Club less than a mile away, and his PhD, on the Borralan alkaline complex, from the University of London. This was followed by a Fellowship year researching the petrology of fenites from major carbonatite complexes of the Chilwa Province (Malawi). After his appointment as a petrologist at the British Museum (Natural History), he continued studying carbonatites and the alkaline igneous and metasomatic rocks. In the 1980s, he commenced writing a series of monographs on these rocks, describing all the known occurrences: the fourth and final volume was published in 2019. He is currently helping Emma Humphreys-Williams who is building a website containing descriptions of all known occurrences of the alkaline rocks and carbonatites.