

# Rocks of ages

BY JONATHAN CHARLES GODDARD

In this series of articles, I am going to show you some of the exhibits contained in the Museum of Urology, hosted on the BAUS website ([www.baus.org.uk](http://www.baus.org.uk)). During a recent junior doctors' strike, whilst I was re-living my houseman days on the ward, one of my consultant colleagues (who was also acting as a 'senior-junior') introduced me to one of his patients whom, he told me, suffered from brushite stones. "Brushite": I thought I'd heard of it, beyond that ... nothing! But what a great name, where does it come from? I'd heard of struvite, but are there any other great stone names and, more importantly who, if anyone was Brush? I had to do some digging (sorry!).

Ninety-eight percent of all urinary stones are made of calcium oxalate, calcium phosphate, urate, struvite or cystine. Eighty percent of all stones are calcium stones and up to 80% of calcium stones are made of calcium oxalate. Calcium oxalate has two main crystalline forms, calcium oxalate monohydrate, also known as whewellite and calcium oxalate dihydrate also called, weddellite.

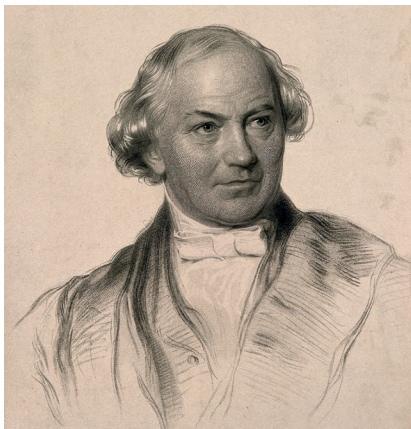


Figure 1: William Whewell. Stipple engraving. Wellcome Collection. Image in the Public Domain.

## Whewellite

Whewellite (calcium oxalate monohydrate) was first described by the English crystallographer and mineralogist Henry James Brooke (1771–1857) in 1840 as "crystallised native oxalate of lime". In the revised edition of Brooke's book on minerals, the editor William Hallows Miller (1801–1880) named it whewellite in honour of Rev William Whewell (1794–1866) an English scientist and polymath (Figure 1). Whewell was Master of Trinity College

and amongst his many achievements, came up with the words, scientist, physicist and linguistics, and suggested the terms, ion, electrode, cathode and anode to the electricity pioneer Michael Faraday (1791–1867).

## Weddellite

Weddellite (calcium oxalate dihydrate) was described in 1936 by Frederick Allen Bannister (1901–1970) and Max H Hey (1904–1984) of the British Museum. The name only appears however, in 1947, in a paper by Edwin Prien (1937–1922) and Clifford Frondel (1907–2002). It was named after the place it was found, the Weddell Sea in Antarctica. The Weddell Sea in turn was named after James Weddell FRSE (1787–1834), a British sea captain who, on a seal hunting expedition in 1823, sailed to the southernmost position any ship had ever reached at that time (Figure 2).

## Apatite

Calcium phosphate stones account for just under 10% of all stones and about 20% of calcium containing ones. There are several different types, and their formation depends on the urinary pH and calcium content; they form in alkaline urine, with a pH of more than 6.5.

The most common phosphate stone is apatite; this can be carboxapatite or hydroxyapatite. Carboxapatite means carbonated apatite. To carbonise is to add carbon dioxide. I have to be honest here, my first thoughts on this went to carbonated water and swiftly to whisky and soda but a better analogy would be the slow carbonisation of concrete over time by the absorption of carbon dioxide thus strengthening it; think of the still standing 2000-year-old concrete roof of the Roman Pantheon!

The apatites are a group of phosphate minerals often containing fluoride or chloride. They are very commonly found in geology, as hydroxyapatite, a major



Figure 2: James Weddell and his ship, the Jane on a 1973 postage stamp from the British Antarctic Territory.



Figure 3: George Jarvis Brush. Woodcut from Popular Science Monthly Volume 20. 1881-1882. Image in the Public Domain.

component of tooth enamel and bone. The name was coined by the German geologist Abraham Gottlob Werner (1749–1817) who, finding them deceptively difficult to distinguish from other minerals used the Greek word *apatáō*, meaning fraud or deceiver. So, you can think of apatite stones as the urological equivalent of fool's gold!

## Brushite

Brushite is dicalcium phosphate dihydrate or calcium monohydrogen phosphate. It is a precursor of carboxapatite and when the body does not convert it into a carboxapatite stone it remains as a brushite one. It is, unlike carboxapatite, extremely hard, so much so, it doesn't respond well to ESWL management. Brushite is named after George Jarvis Brush (1831–1912) a professor of mineralogy at Yale College in America (Figure 3), but he did not describe it. It was identified in 1864 by Gideon Emmet Moore (1842–1895), of the University of California, in a specimen of guano. This piece of mineralised bird dropping was a 'kind' gift from a Mr William E Brown of Mare Island, California. He, apparently, had found it in a cargo of guano in New Jersey. After some detective work, the origin of the guano and the first piece of Brushite was found to be Avis Island in the Caribbean. I have not been able to establish why on earth Mr Brown was searching through guano or indeed what prompted him to post some to Dr Moore.

## Struvite

Struvite is magnesium ammonium phosphate hexahydrate (NH<sub>4</sub>MgPO<sub>4</sub>·6H<sub>2</sub>O). Struvite was first discovered by Swedish geologist Georg Ulex (1811–1883) in 1846. It was not, as is

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often claimed, discovered in bat droppings (although bat droppings can contain struvite). The original crystals were actually discovered during an excavation of St Nicholas' churchyard in central Hamburg. Ulex believed that the site was the moat of the much older Neue Berg (New Castle) destroyed in 1072. They were found in a layer of peat below a layer of ancient cow manure. He theorised that ammonia from the cow urine had reacted with the phosphates in the manure to form the struvite. Ulex named it after the Russian diplomat and mineralogist, Heinrich Christian Gottfried von Struve (1772–1851) who had a huge mineral collection and was one of the founders of the Hamburg Natural Science Museum (and as a young man was a great friend of Beethoven).

When it is found in renal stones struvite is often called 'triple phosphate', the three phosphates being calcium, magnesium and ammonium. Actually, the pure mineral struvite does not contain calcium, the early scientists who analysed these stones detected some calcium phosphate as well, as it is usually a mixed stone. They are also called 'infection stones' and are always associated with urinary tract infection and alkaline urine. It was Alexander Marcet (1770–1822) in 1817 who made the connection between alkaline urine



Figure 4: Lithograph of Heinrich Christian Gottfried von Struve. Hamburg State and University Library. Image in the Public Domain.

and suppuration (i.e. UTI) in these stone formers. In 1901, Thomas Richardson Brown (1872–1950) of John Hopkins worked out that certain bacteria split urea to release ammonia.

The urease enzyme which does this was first identified by James B Sumner (1887–1955) in 1926, which won him the 1946 Nobel Prize for chemistry.

### Whitlockite

Now, I have to say I'd never heard of whitlockite before I started researching this article, but it can occasionally be found in renal stones, so I thought I'd better include it. It is a rare form of calcium phosphate.

In the body (as opposed to the pure mineral), it also contains magnesium ( $\text{Ca}_9(\text{MgFe})(\text{PO}_4)_6\text{PO}_3\text{OH}$ ). It was first identified by Clifford Frondel of Harvard University in 1941 in rock from the Palermo #1 mine, Grafton County, New Hampshire. He named it in honour of Herbert Percy Whitlock (1868–1948), the American mineralogist and curator at the American Museum of Natural History in New York.

In the body it is found in the femoral heads, but it also occurs in calcified TB lesions and in salivary and prostatic stones as well as renal stones. Finally, whitlockite can be extra-terrestrial; it has been found in meteorites.

Well, I think that's enough 'ites' for now, but be warned, this article has started me thinking about how we have ended up with so many different types of stones, historically I mean. If I find out, I'll let you know.

## AUTHOR AND SECTION EDITOR



### Jonathan Charles Goddard,

Curator of the Museum of Urology, hosted by BAUS; Consultant Urological Surgeon, Leicester General Hospital, Leicester, UK.