

"YOU'RE INTO FLINT, have you seen this?" It started with a tip-off about a copy of a book for sale in a second-hand bookshop.

Flint: Its Origin, Properties and Uses by Walter Shepherd (1972) was offered for sale with the claim that it was the author's personal copy and included hand-written and typed annotations. To a flint enthusiast, it was an irresistible offering.

Interest in flint spans disciplines, from geology and archaeology to architecture, construction, manufacturing, folklore and art. To quote Shepherd from his book's preface, "Flint is remarkable for its

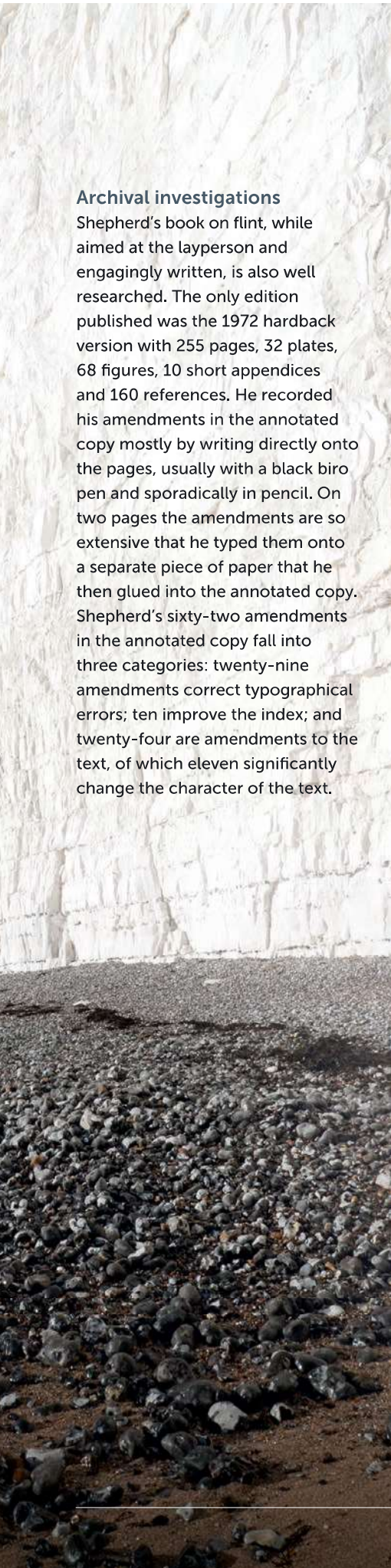
intrinsic qualities, its mysterious origin, its natural journeyings and transformations, and its age-old utility to man." It is therefore fitting that what is arguably the foremost book on the subject was written by a remarkable person, who was, in the words of his second wife "an eccentric of the first order".

Walter Bradley Shepherd [1904 – 1988] joined the Geological Society in 1932. Much of what we know about him as a person is gleaned from the pages of a book written by his second wife (Shepherd & Shepherd, 2010). He appears to have written over fifty published books mostly on science and natural history. He carried out original research in geology and is reputed to have discovered a new species of fossil sea sponge in the Folkestone Formation of Sussex.

The flint shingle beach at Birling Gap near Eastbourne, East Sussex, UK, with the chalk cliffs of the Seven Sisters behind

FLINT THROUGH TIME

JEREMY INGHAM CELEBRATES THE FORTUNATE DISCOVERY OF A CLASSIC GEOLOGY BOOK ON FLINT AND A RECENT DONATION TO THE GEOLOGICAL SOCIETY LIBRARY'S RARE BOOK COLLECTION



Archival investigations

Shepherd's book on flint, while aimed at the layperson and engagingly written, is also well researched. The only edition published was the 1972 hardback version with 255 pages, 32 plates, 68 figures, 10 short appendices and 160 references. He recorded his amendments in the annotated copy mostly by writing directly onto the pages, usually with a black biro pen and sporadically in pencil. On two pages the amendments are so extensive that he typed them onto a separate piece of paper that he then glued into the annotated copy. Shepherd's sixty-two amendments in the annotated copy fall into three categories: twenty-nine amendments correct typographical errors; ten improve the index; and twenty-four are amendments to the text, of which eleven significantly change the character of the text.



Horizontal beds of nodular flint in the chalk rock face of the Seven Sisters cliffs, East Sussex, UK

Shepherd did not write his name in the annotated copy, initially leaving doubt as to whether

it was his. This is where the Geological Society archive saved the day. Shepherd's hand-written application form from when he joined the Geological Society in 1932 is held in the archive. Comparison of the handwriting between the annotations in the book and the application form revealed remarkable similarities and while we can't be certain, it is probable that Shepherd made the annotations.

Information from the archive also helped narrow down the date range for when the annotations were made. An annotation on page 7 involves inserting 'the late' before Mr. C.P. Charwin. Charwin was a Fellow of the Geological Society who died in 1975, implying that Shepherd made the amendment between Charwin's death in 1975 and his own death in 1988. Shepherd would have been aged between 71 and 84 when making the annotations, which may explain why a second edition was never published. I obtained the annotated copy in 2009, indicating that it entered the book trade at some point between 1988 and 2009.

Meet the flintstones

Flint is a variety of chert that occurs in the Upper Cretaceous Chalk of Northern Europe and other chalk units in parts of the USA and Middle East. It is observed within

“Flint nodules are composed of finely crystalline silica-derived skeletons of marine organisms such as sponge spicules and radiolaria”

chalk as sheets and nodules of various shapes that often form in bands, typically 10–20 cm thick, that can extend over large distances. Flint nodules are composed of extremely finely crystalline silica-derived skeletons of marine organisms such as sponge spicules and radiolaria. They also include minor amounts of calcite and clay minerals.

Flints eroded from chalk bedrock accumulate in a variety of superficial deposits. The most familiar to the layperson are the banks of flint shingle seen on beaches. Less familiar are deposits of fluvial, fluvio-glacial and marine gravels, for example, those of Southeast England. Flints are also found within superficial deposits of Head or Clay-with-flints above the Chalk, which are often the source of flints seen in farmers' fields.

In chapters 2 and 3 of his book, Shepherd sets out various theories for the formation of both chalk and flint that were prevalent

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HISTORY



The 1748 exterior wall of St Michael in Lewes Church, Sussex, with finely coursed knapped flint

© iStock

at the time of writing. While much of the text remains relevant, more than fifty years have passed since publication, so inevitably knowledge has moved on. For example, research over the past 25 years has revealed that the Cretaceous Chalk of northern Europe is considerably more varied than was previously thought (e.g., Mortimore, 2019). The overall mechanism of flint formation is better understood with a detailed explanation being provided by Clayton (1986). While complicated it can be summarised as follows. Biogenic silica breaks down at depths of 1-5 metres in the sediment on the bottom of chalk seas. Complicated biochemical processes in a layer present at sediment depths of less than 10 metres cause the dissolved biogenic silica to precipitate and replace

FURTHER INFORMATION

The personal, annotated copy of Walter Shepherd's book, *Flint: Its Origin, Properties and Uses*, is now part of the Geological Society's Rare Books Collection and is available to view in the Library at Burlington House.

chalk; with later burial and over time it transforms to flint. Flint nodule morphologies are often related to trace fossils, as the nodules preferentially form in and overgrow the filled burrows of marine organisms taking on their shape (Bromley & Ekdale, 1986). Flint forms in bands within chalk possibly because chalk sedimentation occurs in cycles or because flint formation periodically exhausts the silica supply and can only recommence when the supply is replenished. One area that has moved on considerably is engineering geology.

The properties of Chalk bedrock and embedded flint are of great importance to drilling, tunnelling and construction operations. Since Shepherd's book was published, engineering classification systems have been developed for Chalk and flint (e.g., Lord, Clayton & Mortimore, 2002; Mortimore, 2014). The physical properties of flints that could affect rates of wear and penetration of drilling bits and cutting heads of tunnel boring machines are now much better understood. For example, research carried out by Fiona Cumming in 1999 provided the first comprehensive testing of flints, while a 2017 paper by Aliyu and colleagues benchmarked various physical and mechanical properties of flints from several different regions by laboratory testing of samples. A key finding was that flint strength is surprisingly variable. Strength is related in part to silica content (with high silica content providing more dense, strong and stiff flints), but also to the mineralogy of the quartz polymorphs, the chemical stage and thus age of the flints (with younger flints often being more unstable than older flints in construction environments), as well as the size of the flints.

A most important rock

Shepherd tackles flint in archaeology in chapter 5 of his book, which opens with "Flint was surely the most important of all the rocks and minerals used as a raw material by Stone Age man". He describes how flint was mined (or otherwise sourced), traded and used to fashion a multitude of different primitive tools and weapons. Much of this chapter is still relevant but is now best read in conjunction and comparison with more modern handbooks (such as, Luedtke, 1992 and Butler, 2005).

Use of flint in industry and construction is discussed in chapter 6. From the Middle Ages through to modern times, flint building formed an important part of

“ Shepherd's book remains a classic text for anyone interested in the subject ”

the vernacular architecture of Southeast England and East Anglia. Construction of traditional flint walls involves setting flints in lime mortar. The flints are variously used unworked, snapped or knapped, and can be laid randomly or in courses. Southern England has a large stock of old flint buildings, many with Listed Building status. Repair and maintenance of these requires a knowledge of traditional craft techniques. A common failing of inexperienced/unsuitable contractors in recent decades is the use of inappropriate mortar (Ingham, 2009). On page 196, Shepherd recognises that lime mortar for flint walls must be stiff to prevent rounded flints rolling out of place while it sets.

While the craft traditions for repairing flint buildings have largely remained unchanged for centuries, specialists also undertake some new build projects, which may be architecturally and/or technologically innovative. I showed David Smith, one of England's foremost flint building practitioners and author of a highly recommended modern book on the subject (Smith, 2024), the annotated copy of Shepherd's book. One of his first comments was, "Shepherd's book is iconic".

The largest industrial use of flint is when flint-rich gravels are used as aggregate in concrete. While Shepherd mentions this on page 203, he pays it little attention, which is surprising given its huge economic significance. In Southeast England, most concrete aggregate is obtained locally from on-land gravel pits and dredged offshore, and the coarse aggregate fraction (nominally greater than 4 mm size) predominantly comprises well-rounded flints. These have the advantages of being strong, with the rounded shape making concrete more workable when it is poured.

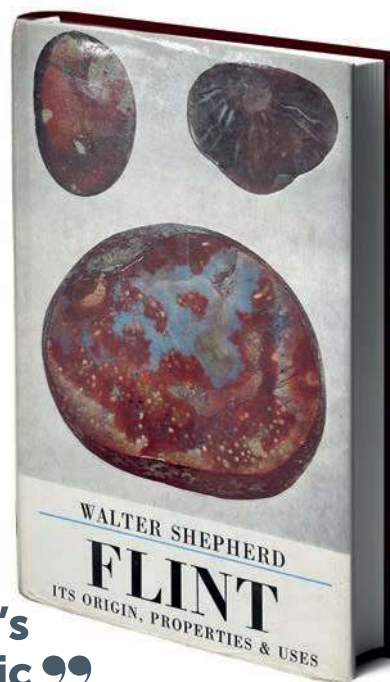
Flint concrete aggregates also have the unfortunate potential to become involved

in a chemical reaction within concrete, something that was incompletely understood in Shepherd's time. Alkali-silica reaction (ASR) involves silica within flint reacting with alkaline solutions in concrete to form expansive alkali-silica gel. This causes concrete to crack, with negative implications for safety and serviceability of

concrete structures. In the years since Shepherd wrote his book, a specialist field of petrography (concrete petrography) has been developed to investigate this and many other issues in concrete. It involves adapting the techniques geologists use for examining thin sections of rocks with polarising microscopes, to the heat and water sensitive nature of concrete samples (Ingham, 2010).

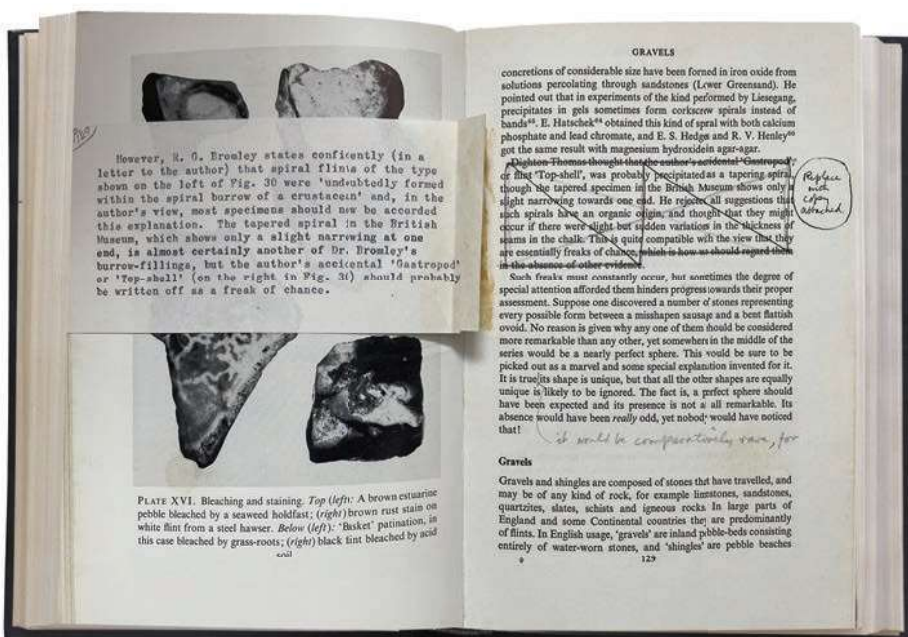
A further

aspect that has been investigated using petrography in recent years is how flint behaves when heated by fire. As Shepherd mentions, in the Stone Age, flints were sometimes used as 'pot-boilers' involving flints being first heated in a fire and then dropped into water or food to assist with cooking. Experimental archaeology involving thin-section examination of flints heated to specific temperatures, show that flints progressively change colour (through pink/red/grey/white) and mineralogy as temperature increases (Ingham, 2005). The transformation flint undergoes when heated by fire bears many similarities to the geological process of metamorphism. This knowledge can subsequently be applied to archaeological investigations where the colour of flint artifacts can be used to estimate the temperature it was heated to. The remarkable colour changes also have a practical application in the field of forensic



Flint: Its Origin, Properties and Uses by Walter Shepherd

“Shepherd's book is iconic”



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An example of Walter Shepherd's annotations to his personal copy of the book

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Appearance of flint specimens following 15 minutes of heat treatment, showing the resulting colour changes (from Ingham, 2005)

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engineering, where they are used to determine the degree of damage caused to fire-damaged concrete buildings (Ingham, 2007).

Folklore and art


Flints play a part in the folklore of places where they are found. In England, flint sea urchin fossils were traditionally prized for their alleged protective powers. They acquired folk names such as 'shepherd's crown', 'fairy loaf' and 'pixy helmet'. In the late Stone Age and early Bronze Age, they were sometimes placed in graves (Bourne, 2024). Flints with a natural hole (called 'hagstones') were considered lucky and were reputedly kept on string worn around the neck, attached to door keys, and hung on bedposts in the hope of supernatural protection or, as Shepherd remarks "to guard against witches and the 'evil eye'".

For thousands of years people have been intrigued by curiously shaped flints, for example, those resembling a head or an animal, or those containing fossils.

Furthermore, the varied shapes and textures of flint nodules have had a significant influence on art. As Shepherd opines, they can assume forms "more fantastic than any sculptor's dream" and the famous artist Henry Moore [1898 – 1986] used them as sources of inspiration for some of his sculptures. Moore is known to have kept flints and other unusually shaped examples of natural materials in his studio. Other artists have incorporated flint nodules directly within their work.

Preserving Shepherd's legacy

Fifty-three years after publication, Shepherd's book on flint remains a classic text and essential reading for anyone interested in the subject. The discovery of the annotated copy is of significance to many fields of scientific endeavor, industry, culture and even fine art. We are privileged to have such an insight into the mind of the author. Analysis indicates that Shepherd was

largely happy with the content of the first edition and was not planning any major expansion or addition for a future second edition. His proposed corrections, minor revisions and updates would have improved both the content and the reader experience. As a second edition was never published, it is fortunate that these planned amendments, which would otherwise have never seen the light of day, are now a matter of public record. The annotated copy has been donated to the Geological Society Library's Rare Book collection, where it is available for scholars to consult. 

Acknowledgements

I am indebted to Roger Miles who tipped me off about the existence of the annotated copy of Shepherd's book and grateful to Caroline Lam, Archivist at the Geological Society of London for assisting with investigating it.



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FURTHER READING

A full list of further reading is available at [geoscientist.online](https://www.geoscientist.online).

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