

# The Origin of Nodular Flint

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The geological theory of the origin of nodular flint in chalk beds contains a number of suppositions but still fails to provide a fully self-consistent explanation of all the observed features of flint. This brief paper proposes an alternative suggestion whereby flint is formed directly from chalk by the Kervran Effect, i.e. by a biological transmutation of atoms of calcium to atoms of silicon and oxygen. A corollary of this hypothesis is that the flint cortex is the site of the former biological activity, which offers the possibility of checking the hypothesis by analysis of undisturbed flint nodules.

## 1. Introduction

Flint is usually categorized as a form of chert. [1] However, the term "flint" should, strictly speaking, be reserved for those varieties of chert which occur as nodules in chalk and limestone formations. [2]

Flint nodules often occur in thin bands within the chalk, clearly associated with chalk bedding planes. Only some of the chalk bedding planes contain flint. In the chalk cliffs of Dover, England, for example, the flint bands are irregularly spaced vertically and are separated by numerous bands of chalk containing no flint at all. [See, e.g. Ref. 3]

Flint is composed of large nodules of silica dioxide. Chalk is composed of calcium carbonate formed from the skeletons of millions of micro-organisms. Clearly, flint cannot have been laid down at the same time as the chalk and this naturally raises the question of how flint is formed.

## 2. The Formation of Flint Nodules

The origin of flint is still a matter for debate. Most authorities will refer to diagenesis, that is, conversion in situ of the chalk into flint, but with much speculation on how this might have come about. Usual explanations include precipitation from a solution of silica (silicon dioxide) which originated from the skeletons of dead organisms. [3] Precipitation of silica is often thought to have occurred in holes in the surrounding chalk formed by burrowing mollusks or crustaceans.

The pure silica core of flint nodules is often surrounded by a whitish cortex. The undisturbed cortex is usually between 6 – 25 mm thick. The majority of the cortex weathers off easily once the flint nodule is removed from the chalk strata but a thin layer of cortex always remains attached to the flint core. [4]

The cortex is sometimes said to be chalk; however, tests with acid reveal that the cortex, and especially the inner cortex that does not weather off the flint core, is also silica. [4]

Some authorities have pointed to the association of flint nodules with fossils found inside the flint and have suggested that the decaying animal causes the precipitation to occur around the skeleton. For example:

*"The process that concentrates dissolved silica locally to form concretions (the flint nodules) is apparently related to the decay of organic material from the dead animals under anaerobic conditions (absence of oxygen). The altered chemical composition of the sur-*

*rounding watery solutions causes the silica to accumulate around the dead body, and occasionally a larger fossil, like the skeleton of a sea urchin, can be found inside a flint nodule."* [4]

However, the majority of flints do not seem to have formed around fossils. Some other explanation appears to be necessary.

What is not explained is why flint should be confined to particular layers in the chalk, or why the nodules are so randomly shaped, or why flint does not occur in small voids in other layers of the chalk as one might expect if the flint has been deposited by percolating water.

Given the uncertainties surrounding the formation of flint and the unanswered questions regarding the process, it appears that there is scope for an alternative explanation.

## 3. The Kervran Effect

C. Louis Kervran (1901-1983) was a French scientist with a distinguished early career. He was a member of the New York Academy of Sciences, the Director of Conferences of the Paris University, a Member of Conseil d'Hygiene de la Seine, and a Member of the Commission du Conseil Supérieur de la Recherche Scientifique (1966). [5]

However, Kervran is best known for his work on biological transmutation of elements [6] which eventually led to his being ostracized from the mainstream science community when his work became associated with alchemy, a viewpoint which is still current today. [5]

The essence of Kervran's argument was that low-energy biological transmutations of elements is the only explanation for a number of anomalies found in nature. [6]

Kervran's early work focused on the ability of chickens to produce calcium-rich eggshells despite having a diet containing little or no calcium. Kervran showed that chickens were only able to produce calcified shells when their diet included potassium-rich oats and demonstrated that therefore there must be a transmutation of potassium to calcium. [5]

Kervran was the French government's recognized expert on radiation poisoning. [5] He was commissioned by the French government to investigate carbon monoxide poisoning of welders working in carbon-monoxide free environments. His conclusion was that the welders were breathing in heated nitrogen from air in contact with the work piece and that the nitrogen was being converted to carbon monoxide by catalysis by the heated iron. This work led to welder's air supply being drawn from are-

as remote from the work piece, which solved the poisoning problem. [6, pp36-40]

Kervran gave many more examples of biological transmutations in his 1966 book 'Biological Transmutations.' [6] These include the apparent ability of actinomycetes to cause 'stone sickness' in sandstones at Angkor Wat by transmuting  $\text{SiO}_2$  to  $\text{CaO}$  [6, p48]; the ability of wheat to produce large quantities of silicon from lime-rich soil [6, Ch.3]; the production of calcium from silica-rich soils by geraniums when bacteria were present in the soil [6, Ch.3]; and the apparent ability of the human body to synthesize calcium for bone repair from silica-rich spring growth horsetail plants. [6, p46]

Kervran concluded that specific enzymes were responsible for the transmutations and that these enzymes are found in the cells of the organisms responsible. [6, s.xii] Furthermore, the transmutations may be reversible by different enzymes. [6, p37]

Kervran explained the transmutations by analogy with chemical valency. He argued that chemistry is based on the exchange of electrons between elements and asked, "*why [should] nature make no use of the rest of the atom, above all the nucleus, where almost all the matter is found?*" [6, s.ix]

The discovery of radioactivity had shown that elements could spontaneously transmute by emission of parts of their nuclei. Therefore, we should expect that nuclei could also exchange protons and neutrons by a similar process if the conditions were right.

For example, nitrogen gas  $\text{N}_2$  has two  $^{14}\text{N}$  atoms held together with a triple bond between their 5-electron valence shells. Following Kervran's suggestion, this arrangement can be pictured as the two N nuclei each with 2-electron inner shells surrounded by a shared valence shell containing the remaining 10 electrons. Kervran argued that it would be possible by catalysis for a proton-neutron pair to be exchanged between the N nuclei, resulting in a triple-bonded carbon monoxide molecule of  $^{12}\text{C}$  and  $^{16}\text{O}$  with the same electron and binding arrangement.[6, p16]

Kervran pointed out that the proposed transmutations did not involve a change in binding energy; only a change in the separation energy was required to transmute bound nuclei. Therefore whilst chemical reactions typically involve  $\sim 1\text{eV}$  of energy and nuclear physics typically involves  $\sim 1\text{MeV}$  of energy, the biological transmutations were an intermediate effect requiring  $\sim 1\text{keV}$  of energy. [6, p39]

Support for Kervran's work has come from an unexpected quarter. In 1978, a report was issued by the U.S. Army Mobility Equipment Research and Development Command which ended: "*It is concluded that elemental transmutations occurring in life organisms are accompanied by losses in mass representing conversion to thermal energy and that such energy probably is a net gain when compared to the amount required to effect the transmutation.*" [7,p9]

#### 4. Flint and the Kervran Effect

Chalk consists of calcium carbonate,  $\text{CaCO}_3$ ; flint is largely silica,  $\text{SiO}_2$ . The conversion of chalk into flint appears to have all the characteristics of the Kervran Effect.

The elemental changes involved are the conversion of  $^{40}\text{Ca}$  to  $^{28}\text{Si}$  &  $^{12}\text{C}$ , similar to the creation of silica from lime-rich soil by growing wheat, for example. The reaction would provide carbon for synthesis by the micro-organism and release of  $\text{O}_{2(g)}$  in a manner analogous to photosynthesis in higher plants.

The micro-organism responsible for this conversion could be expected to live preferentially on the calcareous shells of marine organisms if oceanic conditions were right. This could explain the presence of fossils in some flints. However, the micro-organisms may also have been present in seawater at certain times and hence be present when a new chalk layer was laid down. Layers of chalk without any flint would represent those eras when the composition of seawater was not conducive to the presence of the necessary micro-organisms.

The role of the cortex is then explicable as the zone of biological activity where the transmutation process was actively underway. One would then expect the proportion of silica to increase nearer the flint core; and traces of the biological agent should still be present in the cortex of undisturbed flint nodules.

This offers the possibility to check the hypothesis offered here by investigating whether remains of such organisms are present and, if so, whether they were involved in the conversion of chalk to flint as suggested.

#### 5. Conclusion

The application of the Kervran Effect to chalk leads to an explanation for the diagenetic formation of nodular flint in a manner free of the problems of the conventional geological explanations.

The effect was probably mediated by a plant-like micro-organism which was possibly living parasitically on the calcareous shell of a marine organism prior to the deposition of the chalk. This could explain the presence of fossilized shells in some nodules of flint.

The role of the cortex is explained as the site of the former biological activity and offers the possibility of checking the hypothesis presented here by analysis of undisturbed flint.

#### References

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