

Review of “Code in Crystal” by S. P. Viljoen

Reviewed by R. S. Kurti and P. Marshall

Original Submission to Evolution 2.0 Prize Challenge, Nov. 18, 2018
Subsequent clarification and conversation with S. P. Viljoen through April 2019

Overview of “Code in Crystal”

Viljoen’s work on mathematical symmetry groups in salt crystals focuses on the orientations and patterns of those symmetries. By observing the unit cells and how the atoms in each unit cell is arranged, he forms a lookup table of arrangements, thus forming a simple alphabet. His theory then asserts that these same atomic constituents can be dissolved in water and then reassembled in the same orientations after evaporation.

In laymen’s terms, examining salt crystals from different angles gives rise to consistent “characters”. These can be dissolved the salt in water which is subsequently evaporated, and the same orientations and crystal ordering will reappear.

Relation to the Evolution 2.0 Prize Challenge

Summary of Challenge Requirements

The Evolution 2.0 Prize Challenge (hereinafter “Challenge”) expects winning submissions to be able to demonstrate observation of a system with consistent input stimulus leading to an encoded a message, with a minimum level of demonstrable complexity in a digital format, and sent by means of a chemical communication to be subsequently decoded by the same system or another system able to read the encoded message and produce a consistent output, all without the intervention of living organisms.

Essential components of a communication system

consistent input → encode message → message travels → decode message → consistent output

In the review of this entry to the Challenge, note that a code is a method for taking a specific input and observing a consistent, predictable output. From the outside, we should be able to cause or observe a specific input and observe on the other end an output we can predict even before we see the results, because the same input always causes the same output or sets of output behavior. Implied in the minimum alphabet size, word complexity, and communication structure is the requirement for many possible inputs and outputs determined by the size of the alphabet, usable words, and ultimately the possible messages resulting from them.

Why this entry does not fully meet the Challenge requirements

Viljoen's code certainly does have an alphabet as demonstrated by his charts and diagrams. It may even have words (more evidence needed), but it is missing a clear input-encoder and output-decoder that doesn't require another living organism for input/output. Viljoen does not clearly elucidate what is doing the encoding and decoding based on inputs to receive consistent outputs. So while his system demonstrates an alphabet, it doesn't demonstrate coded communication.

Viljoen's submission to the Challenge begins well by defining an alphabet using crystalline salt structures. In his system, the "bits" (see part 7 of the Challenge guidelines) appear to be individual atoms, while the "characters" are orientations of a given "cluster" as he refers to them. Since crystals will orient in a specific fashion based on bonding behavior of the given atoms, the clustering will be consistent as long as no contaminants are present.

However after describing the alphabet, this submission to the Challenge begins to stray from the Challenge requirements. In his description, Viljoen says "the code in the cluster is read by rotating the cluster around the axis formed by any two opposing spheres". However, he never fully describes how the chemicals themselves become encoded based on an input without the need for a human or other living organism. Similarly, there are no details about how the chemicals or chemical system itself creates a consistent output based on the given input. Thus the "Code in Crystal" submission fails to satisfy numbers 4, 6, and 10 of the Challenge guidelines.

Relating to item number 9 from the Challenge guidelines if Viljoen's system demonstrated "input → encoding" (which it doesn't appear to), the encoded message should be able to be intercepted by some reasonable method and verified. However, it does not appear that the message would be readily extracted while in a solution. Upon dissolution or "decoding", we might find the message again, but not if any contaminants were present.

Another issue with the fulfillment of guideline number 9 is that no simple, objective measure is available to observe the "message" phase of the process, because during this phase the "alphabet" is completely disordered in a fluid. While individual characters may reassemble after evaporation, it is unlikely they would reassemble in order. Viljoen's system does not demonstrate clearly how the "message" is kept in order prior to decoding if multiple "characters" (see part 7 of the Challenge guidelines) are to be transmitted in a single message.

Thus the "Code in Crystal" entry submitted by S. P. Viljoen fails to meet the Evolution 2.0 Prize Challenge guidelines 4, 6, 10, and possibly also number 9.

Other observations about this entry

The reviewers have a few doubts about the ability of the "Code in Crystal" system being able to deal with noise. One of the critical components of a coding system is the ability to ensure a high fidelity of message coherence between the input and output. For instance, what would happen in Viljoen's system if contaminants were to be present in the water? Likely outcomes include the unit cells in the output crystal being rearranged leading to a garbled decoding from the original encoding. There appear to be

no mechanisms in the “message traveling” stage for the message to be preserved. Any contaminant in the solvent will destroy the message.

In natural systems using DNA as a code, there are error checkers on the DNA, and if the DNA is broken or damaged during the “message traveling” stage, human cells will be able to repair the DNA as long as there is only one error every ten base pairs. The details of this error correction are actually quite a bit more complex than here described, but suffice it to say that natural systems using DNA as a coding system have very robust error correction. The “Code in Crystal” doesn’t have any clear mechanism for protecting fidelity in the message phase of the communication process.

One final note on this submission revolves around the topic of “theories of everything”. As a serious prize to encourage the discovery of meaningful insights into the mechanisms of naturally arising codes (similar to the DNA code in living organisms), we cannot focus on grand unified theories, etc. While Viljoen made a couple of good observations in his submission, the connections between salt crystal symmetries and the DNA alphabet (AGCU in his nomenclature) verge on a “theory of everything” which the Sponsor of the Challenge wishes to avoid in order to stay focused on peer reviewable science.

The reviewers would like to thank S. P. Viljoen for submitting his “Code in Crystal” entry to the Evolution 2.0 Prize Challenge and invite further exploration to elucidate mechanisms leading to naturally arising communication systems.