Where was the potassium, [K⁺]?

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All living cells have high intracellular potassium concentrations, [K⁺]. How and when did this high [K⁺] appear? There are 2 choices:

1. The prebiotic environment was high in [K⁺] = “Early K⁺”
2. The prebiotic environment was not high in [K⁺], but protocells created a high intracellular [K⁺], from an environment that was not high in [K⁺] = “Late K⁺”.

There are problems with both options.

“Late K⁺” has the problem of how such an elemental aspect of life could have arisen after other processes in the origins of life had begun. The high intracellular [K⁺] is now maintained by an energetically expensive pump, the Na⁺/K⁺-ATPase.

“Early K⁺” has the problem: where was the [K⁺]? It was not in seawater, which has 40x more Na⁺ than K⁺. Two possibilities have been published: in geothermal fields [1], and between the sheets of mica or biotite in micaceous clay [2, 3]. Neither possibility is ideal.

The geothermal fields are described as ‘vapor-dominated,’ and there is not convincing data about the excesses of K⁺ over Na⁺ in geothermal fields [1]. Mica has several advantages [2, 3]. Some of these are the following: Mica was present in the Hadean, and mica’s anionic mineral sheets are held together by a hexagonal grid of K⁺, with a periodicity of 0.5 nm, which is also the spacing of anionic phosphate groups in extended single-stranded nucleic acids, DNA and RNA. Most micaceous clay, however, appeared later on Earth.

This question, “where was the K⁺?” is an elephant in the room of research on the origins of life.