Archean seawater as a sunscreen: UV attenuation and cyanobacterial growth in Fe- and Si-rich media

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The oldest fossil evidence for life on Earth indicates photosynthesis in shallow coastal marine settings[1], however these zones would have been harsh environments bathed in high-intensity UV radiation penetrating the ozoneless Archean atmosphere. Planktonic bacteria are more susceptible to UV damage than mat-forming species as they lack the screening provided by a sheath or an aggregate lifestyle, and so the means by which planktonic bacteria survived and colonized early shallow-water environments remains ambiguous. To address this, we performed UV irradiation experiments examining the growth of the planktonic cyanobacterium *Synechococcus* sp. PCC 7002 in Fe-and Si-rich media designed to mimic Archean ocean conditions[2,3]. We report that cultures exposed to high-intensity UV-C light (254 nm) sustained less genetic damage than irradiated, non-supplemented cultures. Media supplemented with both Fe(III) and Si were significantly more effective at attenuating UV than media supplemented with Si alone. UV attenuation and chemical equilibrium modeling data suggest that Archean seawater should have readily formed Fe(III)-Si polymers and colloids capable of absorbing up to ~70% of incoming UV-C over a 1 cm path length. We suggest that such suspended polymers and colloids may have played an important role in the protection of ancient free-floating bacteria from high-intensity UV radiation, and helped enable phototrophic colonization of nutrient-rich shallow water environments in the Archean.

[1] Allwood *et al* (2006) *Nature* **441**, 8 [2] Czaja *et al* (2012) *GCA* 86 [3] Maliva *et al* (2005) *GSA Bulletin* **117**,7-8