6.6.P02

Peptide synthesis in simulated deep sea hydrothermal environments

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The synthesis of oligomeric biomolecules such as peptides is the key step marking the evolution from prebiotic chemistry to biochemistry [1]. While monomer synthesis has been demonstrated to proceed in high-energy impact shock, lightning, cavitation or UV-radiation dominated environments [2], monomer oligomerization requires lower energy yields, [3], typically found in geological settings such as deep-sea hydrothermal environments (DSHE). In particular, increasing temperatures are predicted to shift the thermodynamic equilibrium between amino acids and product peptide as well as between precursor and successor peptide toward the product oligopeptide [4,5], however, this hypothesis has not been tested experimentally. Using hydrothermal gold cells we demonstrate the formation of short peptides from the amino acid glycine in the temperature range 160ºC to 260ºC and 200 bar, conditions typical of DSHE. We show that glycine and product peptides enter into equilibrium and demonstrate a lowering of the Gibbs energies of diglycine and diketopiperazine formation from glycine with increasing temperature. Our results confirm that the thermodynamic stability of the peptide bond in diglycine and diketopiperazine increases relative to the free acid with increasing temperature 4]. They support a high temperature origin of life and the early emergence of peptides during chemical evolution.

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6.6.P03

Characteristics of organic matter in sediments from the 3.24 Ga Sulphur Springs VHMS Deposit, Western Australia

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With modern sea-floor hydrothermal vent environments having been shown to host a wide-ranging variety of primitive microbial life [1,2], the very low strain, low metamorphic grade (prehnite-pumpellyite facies) [3] black shales from the Archaean Kangaroo Caves Formation in the Pilbara Craton of Western Australia [4], present as a potentially favourable early-Earth analogue. Previously described as Earth's oldest black smoker [3,5], the 3.24 Ga Sulphur Springs VHMS deposit formed at a water depth of at least 1000m [3]. Capped by silicified syndepositional volcaniclastic-epiclastic sea-floor sediments, it retains an exceptional level of textural and structural preservation [3], strong evidence for a lack of post-depositional deformation or fluid alteration.

Here we report the isolation of well preserved, filamentous, isotopically light (bulk $\delta^{13}C$ values between -26.7 and -33.1‰ PDB) organic matter (OM) from diamond drill core samples. While previous studies have identified pyritic filaments from the associated hydrothermal cherts of this deposit [6], this study differs in that the finely striated, lenticular to spindle-shaped OM agglomerates occur within fine-grained epiclastic sediments. Optical microscopy and TEM imagery reveals the OM as occurring parallel to bedding planes, in forms reminiscent of both modern-day and more ancient 'microbial mats' [7], while the thermal maturity results (0.2-0.3% Ro) in rocks which return an average of 1.3% TOC (range 0.5% to 1.9%), suggest maximum temperatures not greater than 80°C. Although being far from conclusive, these results are suggestive of a well-developed Archaean sediment-hosted microbial community, situated relatively proximal to an active centre of seafloor hydrothermal activity.

References

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