Thirty years of deep-sea hydrothermal microbiology: Where are we now?

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Over the past 30 years, microbiologists have explored deep-sea hydrothermal vents, describing new species, identifying symbioses and establishing upper temperatures limits for life. In the early 1980's, Holger Jannasch and others, established the chemosynthesis framework for the basis of the microbial food chain at vents, and subsequently much of the research discoveries revolved around autotrophy and symbioses. With the temperature of hydrothermal fluid exceeding 100°C, several hyperthermophiles were isolated, setting temperature records for life, and challenging our imagination of life in this solar system. However, it was only with the advent of the use of molecular biological approaches (and now high throughput sequencing technologies) to describe the diversity associated with hydrothermal vents that we are truly beginning to appreciate the extent of the microbial life at vents. These inventories have helped guide cultivation attempts of novel and endemic lineages from deep-sea vents. Coupling diversity patterns to biogeochemical measurements and geological processes is also providing insights into the factors that might influence microbial colonization at deep-sea vents. I will trace the history of microbial research at deep-sea vents, highlighting some milestones, recent research and possible future directions.

Densities of dilute adenosine solutions to 50 MPa and 373.15 K

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Adenosine is a nucleoside formed from the attachment of ribose to the nucleobase adenine. It plays an important role in cellular metabolism as a structural component of ATP (the molecular unit of currency for energy transfer in cells). Determining its thermodynamic properties is essential for understanding the potential for its formation and reaction properties in high P-T environments that host extremophiles and may have hosted the emergence of life.

The volumetric properties of dilute aqueous solutions of adenosine (0.00284 m, 0.00486 m & 0.007924 m) were obtained using an Anton Paar DMA HP vibrating tube densimeter. Reproducibility of density measurements was $<\pm 0.0001$ g·cm^{-3}, exceeding propagated errors associated with uncertainty in the measurement of temperature, pressure, and fluid concentration.

Comparison of densities for dilute adenosine solutions at 0.1 MPa and 288.15-333.15 K from this study and [1] shows excellent agreement. Experimentally determined volumetric properties for adenosine solutions at elevated pressure and/or temperature are not available in the literature; this study extends the database to 373.15 K and 50.0 MPa.

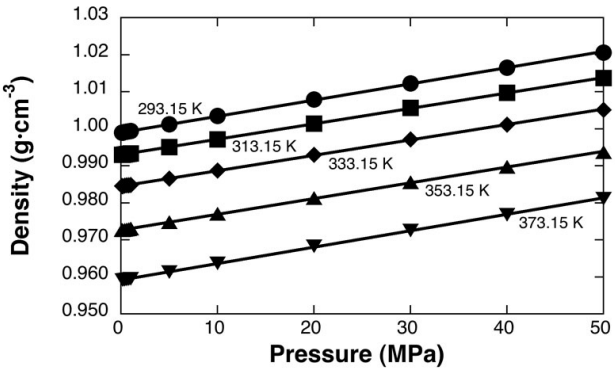

Figure 1: Experimentally determined densities for 0.00792m adenosine solutions to 50 MPa and 373.15 K from this study. Lines represent simple linear regression fits to the data.

[1] Dyke & Hedwick (2008) *J. Chem. Thermo.* **40**, 957-965.