

Life in the Early Archean — Fossils from the Early Archean

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As we peel back the layers of Earth's history and get to possible evidence of the oldest life, the record becomes sparser and more difficult to read, the evidence seems to become dicey, and the stakes get higher. The high stakes cannot to be overlooked. The scientific and personal ramifications can be profound. Evidence for the earliest life falls into three categories: chemical signatures, microfossils, and stromatolites. Such evidence is not questioned normally with Proterozoic occurrences, but comes under intense scrutiny when reported from the Early Archean. This is not inappropriate. However, the lessons learned from the Proterozoic record do not seem to be enough.

Three successions are providing evidence for the earliest life and virtually all of it is contentious: (1) chemical signatures in the Isua Supergroup (ca. 3.85 Ga), and chemical signatures, microfossils, and stromatolites in the (2) Swaziland Supergroup (ca. 3.5 to 3.2 Ga) and (3) Warrawoona Group (ca. 3.5 Ga). Criteria for biogenicity and syngenicity must be rigorously observed. New analytical techniques should be used to test the biogenicity and syngenicity of the Early Archean fossil evidence and be applied to younger, often better preserved material.

The complexity of some microfossil associations (e.g., the small filament, *Archaeotrichion contortum* Schopf, wrapped around the large filament, *Primaevifilum septatum* Schopf, in chert from the Dresser Formation, Warrawoona Group; see Awramik et al., 1983; Awramik, 1984) are difficult to dismiss entirely by an abiogenic interpretation. Likewise, the biogenicity of coniform stromatolites described by Hofmann et al., 1999, from the Strelley Pool Chert (Warrawoona Group) is difficult to dismiss entirely based on superficial similarities to structures produced abiogenically.

References

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Thermodynamic equilibrium in the water-unsaturated zone (UZ) of geological systems

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Hydrogeochemical modeling of unsaturated-zone (UZ) processes classically uses traditional formalisms despite the fact that these were developed for saturated-zone (SZ) systems. Here we show that focusing on UZ chemistry requires a re-evaluation of the free energies of reactions (ΔG_R) that takes into account the capillary pressure of soil solution – this is always lower than 1 bar in the UZ and can even be strongly negative, depending on the soil air humidity.

Calculations of the thermodynamic constants for standard states of gases, aqueous species and minerals were carried out using a hybrid formalism combining the most recent water-state equation (Wagner & Pruß, 2002), the formalism from Mercury & Tardy (2001) and revised HKF equations (Tanger & Helgeson, 1988). Ionic strength effects were taken into account using Debye-Hückel, Davies or Pitzer equations. This integrated approach allows geochemical calculations for the UZ and the SZ to be performed within the same theoretical frame.

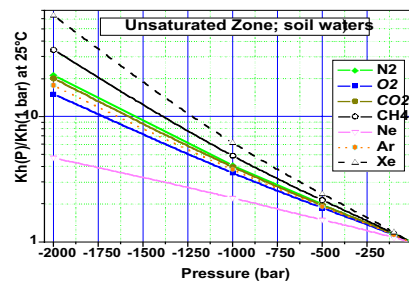


Figure 1. Henry's law constant at negative solution pressures compared (ratio) to that at 1 bar.

Generally speaking, the solubility of soil minerals decreases with decreasing relative humidity (negative pressure). In contrast, the solubility of rare gases (i.e. Ar, Xe, etc.) and reactive gases (i.e. CO₂ and O₂) increases, as is clearly shown by Figure 1 where Henry's law constant increases with decreasing pressure.

References

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