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Characterizing the Neoproterozoic Environmental Conditions using Halite from the Lancer 1 Drill Core, Western Australia

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The Tonian, the first geological time period of the Neoproterozoic Era, is characterized by vast changes in Earth's biosphere, atmosphere, and lithosphere, of which the influence of these processes on the development of hard-bodied life remains debated. Therefore, research into the paleoenvironmental conditions of this time period is essential in determining the role of Earth's systems on the evolution of life. Halite is a valuable paleoenvironmental proxy, owing to its ability to trap and preserve surface waters and atmosphere during its crystallization at the surface-water interface of shallow marine basins. These pockets of homogenous fluids are referred to as primary fluid inclusions, and are characterized by their presence as square inclusions found in trails following the growth pattern and orientation of the cubic halite structure. Primary fluid inclusions have been shown to yield reliable and accurate results that are a direct measure of climatic conditions[1]. Therefore, the objective of this project was to utilize primary halite materials to obtain a "snapshot" of the atmospheric composition and temperature of the Neoproterozoic Era.

Large halite deposits dated to the Tonian period were collected from the Lancer 1 drill core in the Officer Basin of Western Australia. Trace element analysis confirmed the diagenetic integrity and formation environment of the samples, through the careful examination of Br, Cl, Mg, K, and Sr contents. Microthermometry was used to constrain environmental temperatures and yielded results of ~ 36.3 +/- 1.0^{o}C. Quatitative fluid inclusion gas analysis was conducted by cold-crushing the Tonian samples via dual-quadrupole mass spectrometers. These revealed oxygen levels of ~ 12.48 +/- 1.05%. The results of this study provide evidence of a non-glacial environment with oxygen contents above 50% of present atmospheric levels. This suggest that the Neoproterozoic environment was well-underway in developing an environment which would eventually support the emergence of hard-bodied organisms.

[1] Blamey, Brand, Parnell, Spear, Lécuyer, Benison, Meng & Ni (2016). *Geological Society of America 45*, 231-241.