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Halogen composition of Paleoproterozoic oceans

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The salinity of ocean water influences surface temperature and ice cover. The effects are modest today, but salt may be a key ingredient for early Earth habitability in the distant past, perhaps helping to keep Earth warm and ice-free when the Sun was less luminous [1].

Hydrothermal quartz precipitated in cavities and interstitial spaces between seafloor pillow lavas formed by mixing of seafloor hydrothermal (magmatic) fluid and seawater. Hence, the study of fluid inclusions trapped in Archean-Proterozoic age hydrothermal quartz has provided insights into seawater salinity variations in the past [2]. However, there are uncertainties about whether quartz formed during seafloor hydrothermal circulation, or in later thermal events.

In this study the abundances of chlorine, bromine and iodine are being determined in hydrothermal quartz samples from Paleoproterozoic basins covering the time interval 2.5-1.7 Ga. This interval includes both the Great Oxidation Event (2.4-2.6 Ga) and the first global glaciation (2.2-2.3 Ga). Our aim is to track changes in ocean halogen ratios and salinity throughout this period to explore possible relationships with environmental change. Our approach utilises noble gas neutron irradiation mass spectrometry coupled to crushing and stepped heating release of noble gases. This has the potential to provide age constraints coupled with insights into seawater halogen ratios [3] and can help to constrain the origin of any additional trapped fluids.

Results from hydrothermal quartz samples from several Paleoproterozoic Fennoscandinavian greenstone belts in northern Russia, indicate ancient seawater variably mixed with at least two other fluid sources: (1) a high I/Cl fluid (≤2000× seawater), similar to modern marine pore fluids; and (2) hydrothermal fluids with high Br/Cl (≤4× seawater) similar to previously identified hydrothermal fluid in Archean quartz (e.g. Kapvaal, [4]. The halogen ratios of the Paleaoproterozoic seawater component are similar to previous estimates based on cherts of similar age [3].

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