Chloride Variability Measured in High Temperature Hydrothermal Fluids with an *in situ* Sensor

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In Hydrothermal systems, phase separation and the resultant segregation processes produce two fluids with very different properties in parameters such as density and chemical composition. One of the most profound effects of phase separation on composition is the preferential partitioning of chloride into the more dense 'brine' phase along with other major elements. The concurrently produced 'vapor' phase is thus depleted in chloride as well as enriched in volatile components. The phase separation process is now recognized as the most important control on the concentration of chloride in hydrothermal fluids. Chloride concentration is, in turn, one of the most important controls on hydrothermal alteration. This control is imparted through the importance of chloride in determining mineral solubility by its effect on the formation of metal complexes, ionic strength, and in maintaining charge balance.

The efficacy of chloride measurements in diagnosing the ubiquitous and significant impact of phase separation on hydrothermal fluids demands that we possess a reliable way to make this measurement on a long-term basis in a very hostile environment. Moreover, owing to the highly dynamic nature of mid-ocean ridge hydrothermal systems evidenced by rapidly changing chemical compositions following magmatic events at 9ºN and Endeavour, our capability to make chloride measurements must be sufficiently rapid to capture changes on very short time scales.

Previous research has already shown that tectonic and magmatic events can have dramatic effects on the overlying hydrothermal systems. However, the discrete fluid sampling methods responsible for these conclusions are unable to define the instantaneous nature of quickly varying processes. A continuing presence of *in situ* sensors with sufficiently detailed spatial coverage of a ridge environment will fill in the gaps left by conventional fluid sampling. Only an established *in situ* method can adequately characterize the temporal variability of chloride and thus follow the nature of phase separation during transient events.

We have developed an instrument that measures fluid resistivity which serves as a good proxy for chloride concentration in high temperature hydrothermal fluids. These instruments have so far been deployed successfully at both Endeavour and 9ºN and have recorded heretofore undetected variability in chloride concentrations on multiple time scales. At Endeavour, the most pronounced variations are tidally induced but variations on longer time scales are seen. At 9ºN, in addition to chloride variations occurring over several days, significant chloride changes on the time scale of minutes are also seen and these appear to be linked to seismic activity.

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