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Effects of anhydrite precipitation on hydrothermal convection patterns at fast-spreading ridges

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Recent advances in hydrothermal modeling capabilities have revealed the key thermodynamic and fluid-dynamic controls on hydrothermal convection patterns and vent temperatures at oceanic spreading centers. The observed upper limit to black smoker vent temperatures of approx. 400°C can be explained by the thermodynamic properties of water (Jupp and Schultz, 2000). Likewise, 3D models of hydrothermal flow at fast-spreading ridges show cylindrical upwellings with adjacent warm recharge flow (Coumou et al., 2008). This close relation between dis- and recharge flow implies that hydrothermal convection cells have a relatively short wavelength ($\sim$500m), which is difficult to reconcile with ideas on elongated along-axis convection cells proposed for the East Pacific Rise (Tolstoy et al., 2008) and with the irregular spacing of hydrothermal sites along ridge segments. One possible additional process controlling the spacing/wavelength of hydrothermal convection cells may be chemical precipitation reactions. A key reaction in hydrothermal systems is the precipitation of anhydrite. In recharge zones, heating of 1 kg of seawater to approx. 350°C results in the precipitation of roughly 1.4 g of anhydrite, which is buffered by the amount of calcium dissolved in seawater. More significant may be the precipitation of anhydrate when calcium-rich hydrothermal fluids mix with sulfate rich seawater. A consequence of anhydrite precipitation is the progressive clogging of pore space, which in turn affects permeability and thereby hydrothermal flow. We have implemented the above processes into 2D and 3D hydrothermal flow models and will present first results of how chemical reactions can affect hydrothermal flow patterns at fast-spreading ridges.