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Magma-sediment mingling processes, control and longevity of related hydrothermal systems – Implications for the Earth's Carbon-, Plate-, Life-Cycles (IODP Exp 385, Guaymas Basin, Gulf of California)

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Magma-sediment mingling occurring in shallow porous sediments is mainly investigated through field observations of old exhumed rift basins. During the IODP Expedition 385 we have drilled through the shallow sills emplaced in the active rift of the Guaymas Basin, Gulf of California. The results of this expedition enable a pioneer study of the impact of recent magma-sediment mingling processes leading to peperite formation. Furthermore, it provides a present-day geological context to investigate and quantify the impact of this mingling process on the element cycles in subsurface sediments, and temporal evolution of the microbial habitat associated with epithermal hydrothermal fluid circulation. Our approach of exploring magma-sediment mingling processes includes laboratory experiments, numerical modelling, and identification of specific field analogues in addition to petrological and geochemical constraints.

Using these modern techniques, we review here the discoveries made during the IODP Expedition 385 and present preliminary results from our post-cruise research from the perspective of the peperite formation. We report here petrographic and geochemical evidence of magma sediment hybridization indicative of an intense mingling process inferred to occur during the emplacement phase. The rheology of the soft, unconsolidated sediment controls and explains the various intrusion shapes and dimensions. Numerical simulation results indicate that heat dissipation in

this context is much less efficient, which in turn considerably decreases the amount of thermogenic gas mobilized through thermal cracking in the contact aureole of sills. Additionally, we observe that hydrothermal pipe systems established during the cooling phase of sill emplacement can remain active at moderate- to low-temperature state after the heat of the sill has vanished. Using 2D seismic information and IODP drilling results, we were able to reconstruct the 3D structure of the sill at depth. It is funnel-shaped and roots in a depth where geothermal fluids can ascend from. The temperature found at these depths is consistent with the background geothermal gradient, suggesting that the large heat flow anomaly found at Hole U1548C is the mere expression of the active hydrothermal circulation fuelled by deeply sourced geothermal fluids.

These potentially long-lasting hydrothermal systems provide preferable temperature and energetic conditions for microbial activity to thrive, with mildly degraded petroleum components from below and water recharge from above. Moreover, evidence indicates that the sill at Site U1547 is non-unique at the scale of the Guaymas Basin. How many of these catabolic reactors form at the early rifting phase? Can this process perhaps trigger peaks in subsurface biomass production associated with new continental margin formation? Our research heralds the dawn of a new paradigm. We suggest that in the context of a nascent ocean, sill emplacement in the first 500 m of sediments may power life instead of suppressing it.

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