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Relationships between routing of magma and biosilica diagenesis in the shallow subseafloor of a nascent ocean basin (Guaymas Basin, Gulf of California)

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The diagenesis of biogenic silica is arguably one of the most significant early diagenetic processes in the shallow subseafloor and can also have profound implication for the routing of magma in rift basins. The transformation of glass-like amorphous silica (opal-A) in diatoms and radiolarians into crystalline forms (opal-CT) converts soft and watery biogenic oozes into harder sedimentary rocks. The silica diagenetic front is extensive (km-scale) forming prominent seismic reflectors, causes regional-scale differential compaction, subsidence, and the expulsion of pore fluids. Most importantly, it corresponds to changes in sediment rheology from ductile oozes to brittle, fracture-prone and more permeable sedimentary rocks. The relationships between silica diagenesis and subseafloor magmatism have been investigated by Expedition 385 of the Integrated Ocean Discovery Program (IODP) in the off-axis region Guaymas Basin (GB) of the Gulf of California at the neighboring Sites U1545 and U1546, the latter including a ~70 m-thick sill intrusion, and at Site U1547, where the top of a massive sill was recovered at shallower depths. The lithostratigraphic and mineralogic analyses of the cores recovered by the expedition combined with interstitial water geochemistry and physical properties unveil a new and somewhat unexpected picture of the GB's subseafloor environment. The first discovery is that despite the super-fast sedimentation/burial (up to 1m/kyr) and the very high geothermal gradients, the transformation of opal-A to opal-CT occurs at ~75 ºC or higher *in situ* temperatures which is much hotter (and deeper) than expected based on previous deep-sea core studies, outcrop studies, laboratory experiments or calculated by models. We hypothesize that the apparent 'sluggishness' of silica transformation is the result of the current kinetic model not being able to predict this transformation when burial rates are much faster than typical biogenic sediments in open ocean conditions for which they were originally created. The second important finding relates the Opal CT-zone with magma intrusions. The massive sill at Site U1546 splits the opal-CT zone, though the latter has identical characteristics (e.g. total thickness, gradual increase in silica crystallization with depth) as the opal-CT zone at the nearby Site U1545, located just outside the extent of the sill. Moreover, the sill intrusion is much shallower at Site U1547 where the opal-CT zone is also shallower due to the higher geothermal gradient (~510 Cº/km as opposed to ~100 ºC/km at Site U1546). Not only these observations suggest that the sill formation postdates the silica phase change, but also that this diagenetic interface controls the way magma moves in the GB subseafloor whereby the opal-A/opal-CT transition zone acts as major physical anisotropy in the sedimentary column to reroute magma

from vertical to lateral movement. In conclusion, this study greatly expands the range of depths/temperatures at which amorphous silica can persists in the subseafloor and establishes fascinating connections between seemingly disconnected processes in the natural world: surface water biological productivity and crustal architecture of a newborn ocean.