Hydrothermal systems and recent eruptive activity in the northern Lau Basin, South Pacific Ocean

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At the northern end of the Tonga-Kermadec system, the back-arc spreading in the Lau Basin is divided among three extensional zones: the Futuna Spreading Center in the west, the Northwest Lau Spreading Center (NWLSC) and Rochambeau Rift in the center, and the Northeast Lau Spreading Center (NELSC) and Fonualei Rift in the east. In addition to these rift zones, the northern Lau Basin is populated with many volcanic cones and calderas. Water-column surveys we conducted from surface ships have identified several sites of hydrothermal activity in this region. In particular, the NWLSC, the Rochambeau Rift, and the NELSC are host to vigorous activity that is creating distinct water-column plumes. Very recently, an expedition to the NELSC found a complex suite of water-column plumes at several levels up to 700 m above the seafloor. Water samples from these plumes contained volcanic glass shards and extremely high hydrogen concentrations. Taken together, these findings point to a seafloor eruption occurring on the NELSC either during or shortly before our survey. At West Mata volcano about 70 km northeast of the NELSC, we also detected unusual plumes over the volcano summit highly enriched in suspended particles, helium, hydrogen, and CO_2. The particles consisted mainly of sulfur and Fe-oxyhydroxides. Multi-beam surveys conducted with the shipboard EM300 system showed extensive areas of high backscatter on the flanks of the volcano. The high backscatter and the plume characteristics point to ongoing and long-lived eruptive activity at West Mata. A return expedition planned in 2009 should allow us to visit these two sites with an ROV (remotely-operated vehicle) and confirm the existence of recent seafloor eruptions.

X-ray microtomography characterization of hydrochemical properties changes induced by CO_2 injection

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Four reactive flow-through experiments were performed on limestone reservoir samples at $T = 100°C$ and total pressure $P = 12$ MPa and various P_{CO2} to mimic mass transfers occurring near ($P_{CO2} = 10$ MPa $\approx P$) and at increasing distance ($P_{CO2} = 6$ to 2.5 MPa) from a CO_2 injection well. Results for $P_{CO2} = 10$ MPa (experiment D1) show non-uniform dissolution features associated with transport-controlled mass transfers, while reaction-controlled uniform dissolution is observed for $P_{CO2} = 2.5$ MPa (experiment D3). The experiment with $P_{CO2} = 6$ MPa (experiment D2) shows the transition from transport- to reaction-controlled dissolution.

All experiments indicate a power scaling between permeability (k) and porosity ( ). The distinctly different scaling exponents characterise the reactivity of the fluid and apears to be independ from the reactive surface area change induced by the dissolution.

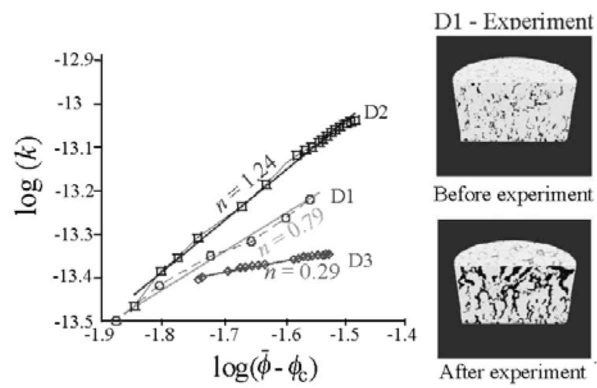

Figure 1: Left: k-ϕ relationship for experiments D1, D2 and D3. Right: XMT images of the inlet side of core before and after experiment.

XMT data is used to investigate the spatial distribution of porosity and the tortuosity within the samples, and explain the origin of the different k-ϕ relationships that characterise the heterogeneous and homogeneous dissolution regimes.

These results can be used to parameterize the k-ϕ function for modeling the earliest dissolution processes occurring in the vicinity of the reaction front.