Internal Structure of Fault Zones in Mid-Oceanic-Ridges: implications for

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Normal fault in oceanic crust are important elements of all Mid-Oceanic Ridges. Although their surface expression is known, almost nothing is known about the internal structure of these fault zones. The brittle character of the mafic oceanic crust promotes the formation of massively dilatant systems and makes these fault zones different from normal faults in weaker rocks, with important consequences on fault zone structure and transport properties. We present a scaled analogue model combined with field studies of the Koa’e Fault system (Big Island/Hawai’i) to provide insight in the faulting of oceanic crust.

The Koa’e is a normal fault system with sub-vertical fault scarps up to 20 m. The formation of large gaping fissures on the footwall is connected with underground openings up to several meters width. Fault scarps are accompanied by a large number of mode-I cracks along existing weakness planes like cooling-joints and bedding features. In our scaled analogue model we used a fine-grained cohesive powder with a tensile strength of 33 Pa. The curved yield locus of the material presents a good mechanical analogue to basalt with a scaling ratio of approximately 1:5.000-40.000. Time-lapse imagery and Particle Imaging Velocimetry was used to analyze the displacement field and fracturing process at high resolution. Boundary conditions include the presence of a buried fault, to simulate the volcanic growth faults in areas of active volcanism and tectonics. Results show structures very similar to those observed in the field: mode-I preceding mode-II movement, the formation of vertical fissures and fault scarps, fragmentation due to mechanical stratigraphy, the presence of large open fissures and filling of fault gaps with wall fragments falling downwards.

The analogue experiments and the field observations imply that massively dilatant structures are common features in Mid-Oceanic-Ridges, to a depth of several hundred meters. The highly open internal structure and the resulting transport properties have a large effect on the network of hydraulic systems. The meter-scaled cavities may provide habitats for the chemosynthetic life forms associated with such black-smoker systems.