Geophysical Research Abstracts, Vol. 7, 03042, 2005
SRef-ID: 1607-7962/gra/EGU05-A-03042
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Internal Structure of Fault Zones in Mid-Oceanic-Ridges

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Normal fault systems are abundant structures at Mid-Oceanic-Ridges. Although the surface expression is largely known from submarine surveys or subaerial outcrops - in e.g. Iceland or Hawai'i – not much is known about the evolution and internal structure of these faults. As opposed to weak sediments, the cohesive oceanic crust promotes massively dilatant structures with large opening magnitudes up to several meters. This has an important effect on the fault zone structure and its 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 processes of oceanic crust.

The Koa'e fault zone is a system with sub-vertical fault scarps up to 20 m height.

Large gaping fissures on the footwall are connected to buried cavities, both with meter scale openings. Initial deformation starts disperse as mode-I at existing weakness planes like cooling-joints and bedding features, before localization promotes further mode-II movement.

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 that allows us to semi-quantify the fracturing process.

The boundary conditions of the experiments were chosen to simulate a volcanic growth fault by covering a buried fault with variable columns of undisturbed mate-

rial.

The resulting structures show similarities to the field observations, including mode-I preceding mode-II movement, the formation of vertical fissures and fault scarps, fragmentation due to the mechanical stratigraphy and the filling of fault gaps with failing wall fragments.

The observations from the experiments and from the field work imply the presence of large dilatant structures associated with fault zones in Mid-Oceanic-Ridges. The architecture of these highly permeable pathways may play an important role for the network of associated hydraulic systems and could provide habitats for chemosynthetic life forms.