Geophysical Research Abstracts
Vol. 12, EGU2010-14333, 2010
EGU General Assembly 2010

Subaerial Seafloor Spreading in Iceland: Segment-Scale Processes and Analogs for Fast-Spreading Mid-Ocean Ridge Spreading Centers

Jeffrey Karson (1), Robert Varga (2), Drew Siler (1), and Andrew Horst (1)

(1) Department of Earth Sciences, Syracuse University, Syracuse, NY 13244, USA (jakarson@syr.edu/315-443-3363), (2) Department of Geology, Pomona College, Claremont, CA 91711 (Bob.varga@pomona.edu/330-465-7183)

The nature of oceanic crust and spreading center processes are derived from direct observations of surface features and geophysics at active spreading centers as well as from deep crustal drilling, tectonic windows into the upper oceanic crust, and ophiolites. Integrating active spreading processes with deeply eroded crustal structures in Iceland provides an additional perspective on subsurface processes that are likely to be important at mid-ocean ridge spreading centers. Spreading in Iceland strongly resembles second-order segment-scale processes of the fast-spreading centers. Along axis, major processes including subsidence, magmatic construction, and hydrothermal activity vary systematically over tens of kilometers from segment centers to ends. Near spreading segment centers ("central volcanoes") subsidence and crustal thickening are greatest. The intrusion of high-level sill and cone sheet complexes and small gabbroic plutons contribute substantially to upper crustal thickening. Both magma supply and tectonic movements have a very strong vertical component. In contrast, near segment ends (fissure swarms in active spreading areas) subsidence is limited, most thickening occurs in the lava units and lateral dike injection is likely to dominate.

In both Iceland and fast-spread crust, where the magma supply is relatively high, subaxial subsidence is the key process that controls the construction and modification of the crust during spreading. Seafloor studies on fast-spreading ridge show lava flows fed by dike intrusion events focused along a narrow (<1 km) axial region with very limited relief. However, subsurface structures reveal that axial lavas must subside hundreds of meters immediately beneath the axis as the overlying lava pile thickens. Similar relationships occur in Iceland but over a wider region of active magmatism (neovolcanic zone tens of kilometers wide) and building a much thicker upper crust ($\sim$5 km). For both cases, in order for the lava units to thicken without the build-up of substantial surface relief, dramatic, focused subaxial subsidence must occur. This subsidence is linked to pervasive brittle damage and block rotations in the upper crust and mass redistribution in the axial magma chamber and underlying low-velocity zone. Subsidence must dominate over lateral spreading at the axis where these processes are masked by surficial lava flows. These results have profound implications for the structure of the oceanic crust, the interpretation of seismic structures, contamination of magmatic systems, heat loss, and the evolution of permeable pathways for hydrothermal systems and habitats for the deep biosphere.