

Tectonic and volcanic interaction along the Lucky Strike rift valley floor: controls on hydrothermal distribution

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High-resolution 120 kHz sonar images and magnetic data of the Mid Atlantic Ridge along the center of the Lucky Strike segment provide insight on the interaction between faulting and magmatism at this segment. A central seamount hosting the Lucky Strike hydrothermal field at its summit overlies a zone of thick crust and a mid-crustal magma chamber (see results from the SISMOMAR'05 cruise, this session). Volcanic activity seems restricted to an axial graben that runs through the middle of the axial valley floor. The graben geometry and tectonic structure vary significantly along-axis, with a minimum width of 2 km where it dissects the summit of the seamount, and reaching >4 km away from the segment center. Deformation extends beyond the graben, as faults radiating from the seamount center, probably associated with flexural loading on the rift crust and collapse of the seamount. Volcanism within the graben has occurred along well defined axial volcanic ridges several tens of meters high and several kilometers long, likely formed following fissure eruptions, or within zones of relatively smooth hummocky terrain with no clear volcanic vents. Lateral extent of volcanic units appears to be limited either by the mode of the eruption (small-volume or slow-rate), or by well-developed scarps within or near the neovolcanic zones. Two overlapping graben with recent volcanism occur at the northern edge of the seamount, where a large positive magnetic anomaly may mark the emplacement thick volcanic units, associated with the seamount emplacement. The Lucky Strike hydrothermal field is located along the trace of the axial graben at the seamount's summit, with vents concentrating at fault scarps. Its plumbing system may be strongly controlled by the extensional tectonism, and may exploit the permeability structure associated with these faults, while mining heat from the underlying mid-crustal magma chamber recently discovered by 3-D seismic techniques. The geophysical data testify to a complex volcanic and tectonic history at Lucky Strike with the emplacement of a central seamount within the rift valley floor after 1-0.7 Ma (spreading age of rift bounding faults) while the graben formed >10-100 Kyr ago (estimated age of the LS hydrothermal system [Langmuir et al., 1997; Humphris et al., 2002]).