

Upper Crustal variations due to mantle temperature variations along the Southeast Indian Ridge

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A systematic variation in axial morphology and axial depth is observed along the Southeast Indian Ridge (SEIR) with distance away from the Australian Antarctic Discordance, an area of cold mantle downwelling. Since spreading rate and mantle geochemistry appear constant along this portion of the SEIR, variations are attributed to a gradient in mantle temperature.

We carried out a MCS survey on the SEIR to determine the effect of changes in mantle temperature on melt supply and crustal structure. MCS reflection data was collected along six segments, showing a range of axial morphology.

These data demonstrate a systematic variation in upper crustal structure. Segment P1 (101 E) is characterized by a well-developed axial high. It shows an axial magma chamber under 60% of the axis at an average depth of 680 msec twtt (~1800 m) and average layer 2a thickness of 270 msec twtt (~325 m). Segment P2 (102 E) is characterized by a poorly developed axial high. Axial magma chambers are found underneath 40% of the axis, at an average depth of 1000 msec twtt (~2200 m) and an average layer 2a thickness of 400 msec twtt (~475 m). Segment P3 (105 E) shows a transition along the segment from an axial high in the west to an axial valley in the east. The axial high portion of the segment has an axial magma chamber (AMC) under almost the entire section located at an average depth of 975 msec twtt (~2000 m), and an average layer 2a thickness of 350 msec twtt (~420 m). The transitional part of the segment again has an axial magma chamber found almost the entire section, located at a deeper average depth of 1000 msec twtt (~2200 m), and an average layer 2a thickness of 400 msec twtt (~475 m). The axial valley part of the segment has no magma chambers, and an average layer 2a thickness of 750 msec twtt (~890 m). Segment S1 (110 E), characterized by an axial valley, shows only a few scattered deep AMC reflections located at an average depth of 1200 msec twtt (~2250 m), and highly variable average layer 2a thickness of 600 msec twtt (~900 m).

There is a clear relationship between axial morphology, crustal thickness, depth to the AMC and thickness of layer 2a along this section of the SEIR. Although axial morphology changes progressively along the axis, AMC extent and layer 2a thickness show abrupt changes along the axis. Magma chambers are commonly observed under axial high segments. As the axial high becomes less well developed, AMC reflections become deeper but still exist over significant parts of the segment. An axial magma chamber is rarely observed at segments with an axial valley. Layer 2a thickness roughly doubles with the transition from an axial high to an axial valley.