Geodesy reveals deep lateral magma flow and complex magma plumbing in Ethiopian spreading centre

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The chain of volcanoes that runs through Afar in Ethiopia marks a subaerial spreading centre separating the Nubian and Arabian plates. In September 2005, a major dyke intrusion ruptured the 60-km-long Dabbahu segment of this plate boundary. The 4-8m-wide dyke was fed laterally from two shallow magma chambers at the north end of the segment and an inferred deeper source near the segment centre. A rapid deployment of ground-based geodetic instruments, and frequent satellite radar passes, have allowed tracking of the temporal and spatial pattern of surface deformation occurring since the major dyke intrusion - the first time this has been possible for a major rifting episode. Since that first intrusion a number of smaller dykes have been intruded in the same segment. Here we show that the post-intrusion response of the magmatic system reveals a magmatic plumbing system that is more complex than previously thought. In addition to the shallow chambers previously identified, a third, mid-segment chamber is present in the mid-crust. Furthermore, a broad subsiding area to the south-east of the rift segment can be explained only by the lateral flow of magma away from a reservoir in the lower crust towards the active rift segment - a distance of at least 60 km. Our results suggest that models of mid-ocean ridge magma systems may be too simple, and especially that transport of magma from sources away from the spreading axis may play an important role.