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Two recent surtseyan eruptions in the Zubair archipelago (Red Sea) studied using high-resolution radar and optical satellite remote sensing

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The birth and growth of new volcanic islands are rare and spectacular geological events that are far from being fully understood. The recent Surtseyan eruptions in the Zubair archipelago, southern Red Sea, from December 2011 to January 2012 as well as between September and November 2013, formed two new oceanic islands and thus provided an exceptional opportunity to study magma-ocean interaction, new-island formation and evolution, as well as coastal erosion. However, no in-situ ground-based geophysical or geodetic measurements were obtained during these eruptions, and we therefore use multiple optical satellite imagery from several different satellites (Ali, Landsat 7&8, Quickbird and WorldView-2) together with high-resolution TerraSAR-X and TanDEM-X radar data to study the volcanic eruptions and how the islands evolved during and after the eruptive activity. The optical images show explosive activity during both eruptions, with a thick white plumes and black tephra rising from the eruptive vents. The images also reveal that the 2011-12 eruption began on $\sim$19 December 2012, was fed from a short NW-SE fissure, and that it ended between 9 and 12 January 2012. The 2011-12 eruption formed a new island that consists of a single elongated cone, oriented approximately parallel to the axis of the Red Sea rift. The 2013 eruption started on 28 September 2013 and went by mostly unnoticed. It lasted both longer (about two months) and formed a larger island, than the 2011-12 eruption. Time series of optical images reveal that significant wind and coastal erosion, as well as possible landslide activity has resulted in changes of both the size and the shape of the two new islands. Regular high-resolution TerraSAR-X satellite acquisitions of the area did not start until on 20 January 2012. These data could provide information about post-eruption deformation associated with the new deposits, but the coherence is not very good on the island formed in the first eruption. However, we used two pairs of TanDEM-X data acquired before and after the 2011-12 eruption to make a high-resolution DEM of the new island and three-pass InSAR to map the ground deformation associated with 2011-12 eruption on the neighboring islands.