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Contribution of the FUTUREVOLC project to the study of segmented lateral dyke growth in the 2014 rifting event at Bárðarbunga volcanic system, Iceland

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The FUTUREVOLC project (a 26-partner project funded by FP7 Environment Programme of the European Commission, addressing topic “Long-term monitoring experiment in geologically active regions of Europe prone to natural hazards: the Supersite concept) set aims to (i) establish an innovative volcano monitoring system and strategy, (ii) develop new methods for near real-time integration of multi-parametric datasets, (iii) apply a seamless transdisciplinary approach to further scientific understanding of magmatic processes, and (iv) to improve delivery, quality and timeliness of transdisciplinary information from monitoring scientists to civil protection. The project duration is 1 October 2012 – 31 March 2016. Unrest and volcanic activity since August 2014 at one of the focus areas of the project in Iceland, at the Bárðarbunga volcanic system, near the middle of the project duration, has offered unique opportunities for this project. On 16 August 2014 an intense seismic swarm started in Bárðarbunga, the beginning of a major volcano-tectonic rifting event forming over 45 km long dyke extending from the caldera to Holuhraun lava field outside the northern margin of Vatnajökull. A large basaltic, effusive fissure eruption began in Holuhraun on 31 August which had by January formed a lava field with a volume in excess of one cubic kilometre. We document how the FUTUREVOLC project has contributed to the study and response to the subsurface dyke formation, through increased seismic and geodetic coverage and joint interpreation of the data. The dyke intrusion in the Bárðarbunga volcanic system, grew laterally for over 45 km at a variable rate, with an influence of topography on the direction of propagation. Barriers at the ends of each segment were overcome by the build-up of pressure in the dyke end; then a new segment formed and dyke lengthening temporarily peaked. The dyke evolution, which occurred over 14 days, was revealed by propagating seismicity, ground deformation mapped by Global Positioning System (GPS), interferometric analysis of satellite radar images (InSAR), and graben formation. The strike of the dyke segments varies from an initially radial direction away from the Bárðarbunga caldera, towards alignment with that expected from regional stress at the distal end. A model minimizing the combined strain and gravitational potential energy explains the propagation path. Dyke opening and seismicity focused at the most distal segment at any given time, and were simultaneous with a magma source deflation and slow collapse at the Bárðarbunga caldera, accompanied by a series of M>5 earthquakes. Joint interpretation of seismic and geodetic data was reported daily to the civil protection of Iceland and used for effective response and mitigation of the associated hazards. The response to, and studies of, the Bárðarbunga rifting event and eruptions have thus contributed to the achievements of all the objectives of the FUTUREVOLC project.