Reviewed research article

Evidence of recent fault movements in the Tungnafellsjökull fissure swarm in the Central Volcanic Zone, Iceland

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Abstract — The volcanic system of Tungnafellsjökull lies in the Central Iceland volcanic zone near the center of the hot spot and the triple junction where the Eurasian Plate, the North-American Plate and the Hreppar Microplate meet. Holcene activity in the Tungnafellsjökull system has been very low, only two small lavas are associated with the system. The Tungnafellsjökull fissure swarm is rather short and wide compared with fissure swarms of other volcanic systems at the divergent plate boundary, 40 km long and 20 km wide. Earthquakes are not common, with usually fewer than 10 being registered per year. Due to these facts, it came as a surprise when InSAR measurements detected movements on faults in the fissure swarm of Tungnafellsjökull during the Gjálp eruption in Vatnajökull in 1996 at a distance of around 37 km from the eruption site. Ground check in 2009 and 2010 revealed evidence of recent movements on faults in the area in the form of fresh sinkholes and fractures, some of which had moved as recently as the spring of 2010. Fresh sinkholes are known to form mostly during faulting events. They are formed when surface soil is washed into underlying, widening cracks in the bedrock. Based on earthquake data and InSAR images these fault movements occurred during three tectonic events, in October 1996 during the Gjálp eruption, in August 2008 and in November 2009. The events are expressed by increased seismicity in the Tungnafellsjökull area, both in terms of number of recorded earthquakes as well as rate of seismic moment release. The earthquakes were all small. The total released seismic moment is equivalent to that of a single earthquake of magnitude 3.4.The widespread evidence of recent fault movements and the small magnitude of the earthquakes suggests that the fault activity is related to magma movements rather than tectonic faulting.

INTRODUCTION

Iceland is located at the mid-Atlantic plate boundary where two major plates meet, the North-American plate and the Eurasian plate. In addition, a microplate has been defined between two branches of the boundary, called the Hreppar microplate (Einarsson, 1991, 2008). The country provides the only place where a divergent part of this plate boundary can be studied on land. Being hot-spot influenced the tectonic picture of the plate boundary in Iceland is more complicated than most other mid-oceanic plate boundaries. The relative motion of the Mid-Atlantic Ridge with respect to the hot spot leads to ridge jumps, propagating rifts and microplate complexities. Complex fracture zones are found in the north (Tjörnes Fracture Zone) and south of the island (the South Iceland Seismic Zone), as well as volcanic zones (Reykjanes Peninsula Rift, Western Volcanic Zone, Eastern Volcanic Zone, Central Iceland Volcanic Zone and Northern Volcanic Zone) (Einarsson, 2008). The volcanic zones are made up of structural units called volcanic systems, which consist of a central volcano and transecting rift zones or fissure swarms (Sæmundsson, 1974; Jakobsson, 1979a). A central volcano is a centrally situated