Tectonic and volcanic deformation at the Azores Triple Junction, observed by continuous and campaign GPS analysis

*Jun Okada[1], João PM. Araújo[2], Alessandro Bonforte[3], Francesco Guglielmino[3], Maria FP. Lorenzo[2], Teresa JL. Ferreira[2]

1.Meteorological Research Institute - Japan Meteorological Agency, 2.Centro de Informação e Vigilância Sismovulcânica dos Açores (CIVISA), 3.Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Catania

The Azores archipelago is located at the junction where three tectonic plates meet: the Eurasian, Nubian and North American plates. It is an area of intense seismic and volcanic activity (Gaspar *et al*. 2015). The boundary between the North American and the other two plates is well defined, but the boundary between the Eurasian and Nubian plates is obscure. Previous geological, geophysical and geochemical studies have revealed diffuse and complex tectonic regime for this boundary zone. The use of space geodesy techniques, such as Global Positioning System (GPS), has provided important contributions to unveiling these diffusive plate boundary characteristics (Fernandes *et al*. 2004, 2006; Trota 2009; Marques *et al*. 2013) as well as detecting volcanic signals (e.g. Fogo Volcano - Trota 2009). The relation between regional tectonics and local volcanic activity is, however, poorly understood. Few attempts have been made to address the detailed spatial and temporal geodynamic processes. The accumulation of data in recent years at S. Miguel Island, is making such attempts possible.
We analyze 9 continuous GPS (CGPS) stations and the campaign data of the island for the period of 2008-2013 using Bernese5.0 software (Dach *et al*. 2007). In order to tie the estimated coordinates to the global geodetic reference frame - ITRF2005, neighboring international IGS station data are simultaneously processed along with the local datasets. By comparing with the current plate angular velocities (DeMets *et al*. 2010), we find a high-strain-rate (0.28 ppm/yr of expansion) zone in the east of Fogo volcano, which accommodates about 50% of the Eurasian-Nubian plate spreading.
Fogo exhibited intense seismic swarm during 2011-2012. The analysis of detrended GPS time-series after subtracting regional plate velocities reveals the existence of two different types of ground deformation associated with the seismicity. One is the edifice-scale inflation of Fogo, which corresponds to the increase in volcano-tectonic events. Another is inflation–deflation reversal in the east of Fogo, which coincides with the sharp decrease in lower-frequency events in August 2012. A strong similarity to the Matsushiro, Japan, earthquake swarm (1965–66) and Campi Flegrei, Italy, volcanic episodes (1969–72 and 1982–85) may suggest importance of the hydrothermal system at Fogo volcano. We propose the following hypothesis for the Fogo unrest: (1) the primary inflation source beneath Fogo promotes lateral diffusion of fluids that is selectively guided by existing cracks/fissures formed from regional extension; (2) an influx of fluids increases pressure in cracks/fissures and generates lower-frequency earthquakes; and (3) discharge of fluids causes pressure decrease and dilatancy recovery (i.e. seismic quiescence). To estimate the source parameters, the result of GPS campaigns is modelled by an integrated inversion using a genetic algorithm. The best fit model agrees well with the regional/local tectonic feature.

Keywords: crustal deformation, GPS, GNSS, plate tectonics, Azores, volcano geodesy

