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Volcanic hazard associated with flank collapses at Stromboli volcano (Italy): inferences from pyroclastic deposits

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Flank instability is a common process at Stromboli and has a significant impact on volcanic hazard as it was revealed by the occurrence of a tsunami as a consequence of the recent flank landslide associated with the last eruptive crisis in 2002-2003. Understanding the causes of volcano instability can be approached in several way, but in any case, it is of fundamental importance for the hazard implication and the impact on the population living and visiting the volcano.

We focused on Stromboli, which is one of the most eruptive Italian volcanoes and our approach was a petrological study of juvenile component from pyroclastic deposits associated with several sector collapses occurred in the last 13 ka with the aim of understanding the correlation between magmatic output and sliding of the instable NW flank of Stromboli.

Four large sector collapses alternating with growth phases have characterised the volcanic activity of Stromboli island in the past 13 ka. All these sector collapses affected the instable NW flank of Stromboli, shaping the present day Sciara del Fuoco, which represent the most instable portion of the volcano. We present a complete dataset of mineralogical, geochemical and isotopic data performed on some pyroclastic deposits of the past 13 ka. Neostromboli volcanic activity followed the Upper Vancori collapse, and was closed by the phreatomagmatic activity of Secche di Lazzaro. Pizzo Sopra la Fossa pyroclastic deposit was outpoured between the two collapses of Neostromboli and Pizzo. Lava fountaining characterised post-Pizzo volcanic activity (Recent Stromboli), which preceded the fourth lateral collapse definitively shaping the Sciara del Fuoco.

Scoriae and pumice represent juvenile material of all deposits and they were analysed in order to determine chemical composition of mineral phases, and chemical and isotopic compositions of whole rocks and separated glassy groundmasses. The Secche di Lazzaro deposit is potassic in composition, showing no compositional difference in respect with the other Neostromboli rocks. The Pizzo Sopra la Fossa deposit is basaltic shoshonitic, whereas the Recent Stromboli products are shoshonitic and high-k calc-alkaline ranging from basalt to shoshonite. Scoriae generally are characterised by porphyritic index higher than pumice. Phenocrysts are composed of olivine, clinopyroxene and plagioclase. Olivine is quite uniform in composition (Fo_{60-72}), whereas clinopyroxene spans a wider range (Mg# 0.66-0.88). Plagioclase phenocrysts generally show high An contents (63-89%), whereas groundmass microlites are Ab-richer (An_{15-50}). High K_2O contents (5.9-7.7wt%) are shown by glassy groundmasses of scoriae and pumices. Glasses from Pizzo scoriae show different composition from that of Neostromboli and Recent rocks. Chemical composition and Sr isotope data on whole rocks allow to better characterise the pyroclastic deposits. Pizzo Sopra la Fossa are the more mafic rocks but they show high $^{87}Sr/^{86}Sr$ (0.70661), along with the more silica-rich rocks of Recent Stromboli. Sr isotope ratios (0.70627-0.70656) and silica contents of Recent Stromboli rocks decrease during time, whereas $^{143}Nd/^{144}Nd$ increase. Our results suggest periodical arrival of new mafic and less radiogenic magmas in the shallow plumbing system. Secche di Lazzaro pyroclasts are fairly heterogenous and different pyroclastic deposits seems to sample portions of magma chamber with slightly different compositions.Lazzaro collapse, however, seems to be triggered by gravitative more than by magmatological causes. Inputs of new mafic magma occurred in correspondence of RSII eruptive periods thus magmatological causes such as plumbing system overpressure might be invoked for the associated sector collapses.