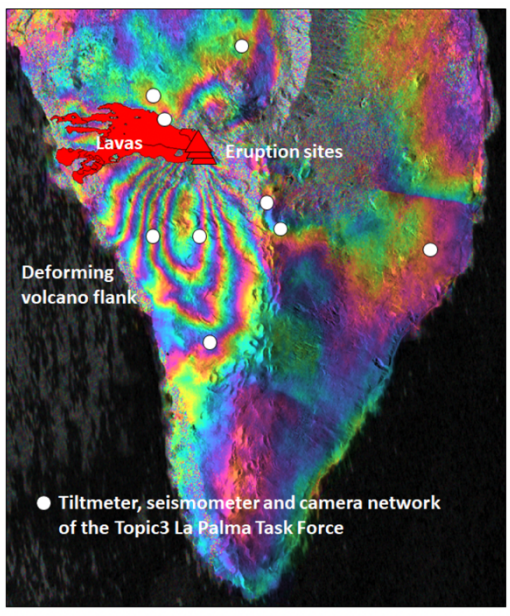
TOPIC 3 Living on a Restless Earth Newsletter

Friday, 5.11.2021

News

Las Palma task force intervention



An example of a differential satellite radar interferogram over La Palma.

A Topic 3 team at the GFZ has set up a task force and sent a team to La Palma to contribute to the rapid assessment of volcanic eruptions and earthquakes on the islands. Together with experts in Potsdam and Spain, the researchers are investigating the interaction of the eruption with the quakes and surface deformations. They are using on-site instruments and satellite images as well as data and software from the worldwide earthquake measuring network GEOFON. After fifty years of dormancy and a three-year seismically active phase, a new volcanic eruption began on September 19, 2021, at Cumbre Vieja on the island of La Palma. Using satellite radar, GFZ researchers detected large-scale deformations indicating a pressure increase beneath the surface. The starting point of the eruption was on the central western flank of the Cumbre Vieja volcanic ridge, just a short distance north of the 1949 eruption. The lava flow is now over 6500 meters long, in places over 2000 meters wide and at some places up to over 25 meters thick. It has destroyed over 2300 houses and numerous roads. The lava reached the coast on September 28, 2021, released poisonous gases. The deformation of the flank is particularly interesting, as the same flank once was speculated to be the site of a possible flank collapse. Soon the team will revisit their stations and hope to collect more data related to the activities at La Palma.

Expeditions

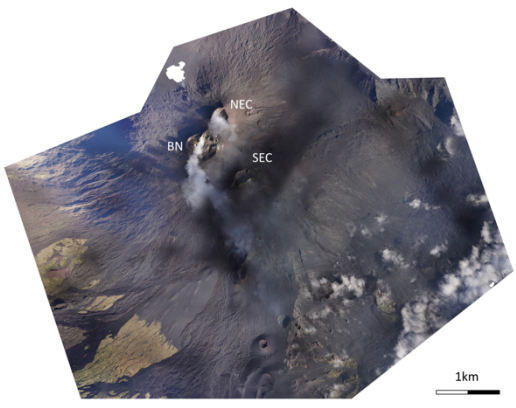
Installation of new seismic borehole and surface sensors at Etna

Within the European funded project “SiC nano for PicoGeo”, Section 4.2 (Aglaja Blanke, Michael Naumann,Marco Bohnhoff) installed the very first seismic borehole sensors ever at Mt. Etna (Sicily). The project (www.picogeo.eu/) is an interdisciplinary collaboration between four interdisciplinary enterprises and three research institutions leaded by CNR-IMM (Italy). The focus sites are located at Serra La Nave directly south of the active craters and in Mascalucia close to the creeping/periodically seismic active Mascalucia-Trecastagni fault segment. At each site, a borehole fullband and a borehole short-period sensor have been installed in a 65m deep and a 1m deep borehole, respectively. Borehole sensors are less sensitive to surface noise and can detect much smaller events than surface sensors. Furthermore, the fullband is able to record both low-frequency and high-frequency events at depth, which increases the range of detected magnitudes and event types (volcanic and tectonic) at Etna. In addition to seismic investigations, the borehole sensors will be used to calibrate new highly sensitive borehole strainmeters (under development, to be deployed by the PicoGeo partners).

Geoscientists from INGV Catania, GFZ Potsdam, and ASIR Ltd. after the successful installation of two borehole seismic sensors at Serra La Nave south of the active SE crater. (Copyright: Section 4.2)

The borehole installations at Serra La Nave have been complemented by a temporary and cross-shaped (402.5m x 296.5m) surface geophone array (ETNARRAY). It consists of ten short-period geophones with the two borehole sensors in its center and serves as a sensitive antenna that allows to enhance seismic investigations of detected events from the borehole sensors,
Combined data analysis from both focus sites and from different types of sensors will contribute to a better correlation of deformation processes between the upper- and the lower southeastern flank of Etna. The densification of the existing network at Etna will further enhance the detection limit of volcano-tectonic signals which can result in more precise forecast of volcanic eruptions.

Changing landscape of an active volcano – a drone survey



Orthomosaic of the study area. NEC: Northeast Crater, BN: Bocca Nuova and Voragine, SEC: Southeast Crater.

The GEOMAR Volcanology Drone Group (Karen Strehlow, Malte Eggersglüß) recently returned from their annual mapping campaign on Etna volcano, Sicily. In a collaboration with INGV Catania, we aim to capture the ever-changing landscape of this highly active volcano in regularly updated photogrammetric maps and digital elevation models. These allow us to quantify the changes inflicted on the topography by the eruptions and analyze morphological features in detail. Etna welcomed us with a beautiful paroxysm within the first week of our stay, a sight that compensates for any field-related problem you could have! The participants and equipment of this year's campaign had to battle erratic weather conditions, but we were rewarded in the end. Our new 3D model of the volcano covers the whole lava flow field and highlights the dramatic modifications of the summit craters due to the many paroxysms.

Science Highlights

Seismic forensics and its importance for early warning

Glacial lake outburst floods (GLOFs) and other catastrophic flood events are a major hazard in many mountainous regions, including the Himalayas, and are a growing threat in a warming climate. The ground shaking caused by the passage of GLOFs and other catastrophic floods offers an innovative approach to early warning. Developments in environmental seismology in recent years have shown that fluvial and mass wasting processes generate distinctive seismic signals, and that the seismic waves generated by GLOFs and other major flash floods can be detected by stations up to 100 km from the flood location. Seismic based flood detection could provide minutes to hours of warning to communities in the path of a flood. The devastating impact of these Himalayan floods was starkly illustrated by 7 Feb. 2021 Dhauli Ganga flood in Uttarakhand, India, which resulted in over 200 fatalities. This event has also provided a test case for seismic-based early warning, as it occurred within a dense seismic network run by the National Geophysical Research Institute of India. Data from this network has demonstrated that such events can be widely detected and located within minutes of initiation, and that the downstream movement of the flow can be tracked through time.

Cook KL, Rekapalli R, Dietze M, Pilz M, Cesca S, Rao NP, Srinagesh D, Paul H, Metz M, Mandal P, Suresh G, Cotton F, Tiwari VM, Hovius N. Detection and potential early warning of catastrophic flow events with regional seismic networks. Science. 2021 Oct;374(6563):87-92. doi: 10.1126/science.abj122

Slow and regular earthquakes interact near Istanbul

Seismic events last from few seconds in tiny regular earthquakes to few days or even months, which are known as slow slip events. Understanding how they interact is critically important to define the seismic hazard and subsequent risk in urban areas.
The Armutlu Peninsula is the most seismically active area directly south of the densely populated Istanbul megacity. A portion of the North Anatolian Fault, running between Istanbul and Armutlu, is currently identified as a "seismic gap" and overdue to produce a large earthquake. In this region, slow earthquakes could be first identified in 2019 thanks to the special borehole strainmeter instruments and developed by researchers from the GFZ German Research Centre for Geosciences, in collaboration with the Turkish Disaster and Emergency Management Presidency (AFAD) and the UNAVCO institute from US. To further connect the slow slip events to the "regular" earthquakes in the region, a dense temporary seismic network "SMARTnet" was deployed in the Armutlu Peninsula, as part of the GONAF Plate Boundary Observatory.
After a regular MW 4.6 earthquake in December 2018, another 30-day slow slip event was recorded, activating the shallower portion of the same small fault. After that, the same fault continued seismically active during an entire year, with more than 1000 earthquakes located on the same small fault.
The recent study reports on these observations and discusses that the larger seismicity rates during the year after the MW 4.6 event are promoted by the occurrence of the slow slip event, as well as the re-distribution from stresses after the main rupture.

Martinez Garzon, P., Durand, V., Bentz, S., Kwiatek, G., Dresen, G., Turkmen, T., Nurlu, M., Bohnhoff, M. (2021 online): Near-Fault Monitoring Reveals Combined Seismic and Slow Activation of a Fault Branch within the Istanbul–Marmara Seismic Gap in Northwest Turkey. - Seismological Research Letters. https://doi.org/10.1785/0220210047

Relationship Between Subduction Erosion and the Up-Dip Limit of the 2014 Mw 8.1 Iquique Earthquake

The aftershock distribution of the 2014 Mw 8.1 Iquique earthquake offshore northern Chile, identified from a long-term deployment of ocean bottom seismometers installed eight months after the mainshock, in conjunction with seismic reflection imaging, provides insights into the processes regulating the updip limit of coseismic rupture propagation. Aftershocks updip of the mainshock hypocenter frequently occur in the upper plate and are associated with large-scale faults identified from seismic reflection data. We propose that aftershock seismicity near the plate boundary documents subduction erosion that removes mass from the base of the wedge and results in long-term normal faulting in the upper plate. The combination of very little or no sediment accretion and subduction erosion over millions of years has resulted in a very weak and aseismic frontal wedge. Our observations thus link the shallow subduction zone seismicity to subduction erosion processes that control the evolution of the overriding plate.

F. Petersen, D. Lange, B. Ma, I. Grevemeyer, J. Geersen, D. Klaeschen, E. Contreras Reyes, S. Barrientos, A. Tréhu, E. Vera, H. Kopp, Relationship between subduction erosion and the up-dip limit of the 2014 Mw 8.1 Iquique earthquake, Geophysical Research Letters, 48, e2020GL092207. https://doi.org/10.1029/2020GL092207, 2021.

Workshops, Seminars & Meeting News

November 16th, 2021 - 10am

Prof. Gregory Beroza will give the next Topic 3 seminar. The presentation will address the important issue of Artificial Intelligence and the seminar is entitled **"Improving Earthquake Monitoring with AI."**
Location: Hybrid (Lecture hall GFZ, Haus H and Online)

November 29-30th, 2021

The **General Assembly 2021** of the program "Changing Earth – Sustaining our Future" is taking place in the BCC, Berlin. Everybody is invited to follow the plenary sessions online. Online link will be distributed, so please save the date.

December 14th, 2021

Extended Topic Board Meeting (including Topic 3 senior scientists and section heads) in preparation of scientific challenges and milestones for 2022 and to address the reporting procedure for 2021.
Online link will be distributed, so please save the date.

People

Prof. Dr. Claudio Facenna is heading the GFZ section "Lithosphere Dynamics since 1.9.2021. With his strong expertise in crustal deformation, active tectonics, orogenic belt uplift and exhumation process, dynamic topography, subduction tectonics and evolution of convergent margins, trench migration and back arc deformation, mantle convection, volcanism and fluid circulation in the crust he covers a broad spectrum of competences contributing to Topic3 but also offering interface options to Topics 5 & 8. Welcome to the team!