ID: 47

Magma reservoir conditions inferred from young, explosive post-caldera El Cajete sequence at Valles Caldera, New Mexico, USA

Jisoo Kim[1], Amanda Clarke[1,2], Kurt Roggensack[1], Dawn Ruth[3], Dawnika Blatter[3]

[1]School of Earth and Space Exploration, Arizona State University, Tempe, USA;

[2]INGV Pisa, Italy;

[3]USGS California Volcano Observatory, Menlo Park, USA

The Valles Caldera, New Mexico, USA was created by two caldera-forming eruptions at 1.6 and 1.2 Myr. The El Cajete sequence is possibly the youngest explosive sequence (74 ka) and resulted from a Plinian eruption that produced pyroclastic density currents and a complex pumice-rich fall deposit. Such a series of varying eruption styles is not uncommon in post-caldera volcanism, but the corresponding magma reservoir conditions are not fully understood. Our study addresses how magmatic source conditions may have controlled the eruption style of El Cajete by examining quartz crystals and their melt inclusions (MIs) from erupted deposits.

Quartz is the dominant phenocryst phase in El Cajete pyroclastics. Cathodoluminescence patterns typically show oscillatory zoning, with an average of 7±3 zones (n=84 crystals). Crystals have Ti concentrations of 20-300 ppm, and most (62) crystals have resorption patterns in inner and/or outer zones. MIs are 20-160 microns in diameter, have SiO_2 contents of 72-78 wt.%, and display little major element variation. Sixty-five crystals have moderately to strongly faceted MIs. Vapor bubbles in the MIs are present in 39 crystals and represent <0.01 to 0.4% of the volume of the host MI.

In terms of composition, morphology, and vapor proportion, the crystals and MIs likely represent multiple periods of growth and thermal histories, which may be related to the complexity observed in the products of the Plinian eruption. Ongoing work to further characterize the crystals and MIs will help to refine the petrologic model and support hazard assessment of the active Valles system.

ID: 60

Seismic sequence and explosion seismoacoustics of the 2018-2023 phreatomagmatic eruption of Semisopochnoi volcano, Alaska

John Lyons[1], Darren Tan[2], Alicia Hotovec-Ellis[3], Alexandra Iezzi[4], Taryn Lopez[2], Matthew Haney[1], David Fee[2]

[1]U.S. Geological Survey, Alaska Volcano Observatory, Anchorage, USA; [2]Geophysical Institute, University of Alaska Fairbanks, USA; [3]U.S. Geological Survey, California Volcano Observatory, Menlo Park, USA; [4]U.S. Geological Survey, Cascades Volcano Observatory, Vancouver, USA

Phreatomagmatic eruptions are a monitoring challenge with small or absent explosion precursors and protracted eruptions that can generate fine ash for years with major societal impacts.

The 2018-2023 phreatomagmatic eruption of Semisopochnoi volcano, Alaska was well-recorded with local seismic and infrasound data. It provides an excellent dataset to investigate explosion characteristics and precursors, and to test new methods for tracking changes in seismic activity as the eruption evolved. We generated a near real-time explosion catalog through a novel implementation of the REDPy repeating event detector that was refined with event locations constrained by reverse time migration. The catalog of over 1000 events shows a high degree of similarity in the infrasound waveforms with only one dominant family, indicating a repeating source process. Seismicity recorded during unrest and eruptions was highly diverse and includes long-period events, harmonic and broadband tremor, and explosions. A family of repeating long-period events began ~1 month before the onset of a new phase of explosions and tremor in July 2021, and we hypothesize that these events could be used to provide early warning of impending explosive activity during future eruptions. To test this hypothesis, we investigate the temporal relationships between seismic signal types, unrest, and multidisciplinary data through a novel catalog of seismicity generated with a machine learning (ML) model trained on Semisopochnoi data. The ML-derived seismic timeline may inform a more generic model of how seismic sequences unfold at other phreatic and phreatomagmatic systems globally that lack local monitoring data.

ID: 96

The last explosive eruption of La Primavera caldera, Jalisco, Mexico

Delphine Sourisseau[1], José Luis Arce[1], and José Luis Macías[2]

[1]Instituto de Geología, Universidad Nacional Autónoma de México, Ciudad de México, México; [2]Instituto de Geofísica, Universidad Nacional Autónoma de México, Antigua Carretera a Pátzcuaro 8701, Morelia, Michoacán, México

La Primavera is a Quaternary volcanic field located in the occidental part of the Trans-Mexican-Volcanic-Belt (TMVB). La Primavera was active between 143.5 ka and the present. After the formation of the caldera ~95 ka ago, several domes and stratovolcanoes were emplaced on the rim, inside, and outside the caldera. This activity was accompanied by an intense explosive activity that deposited fifteen pyroclastic deposits (named units GP and A to N) between 86.4 and 25.6 ka. Recently, a young pyroclastic unit named O was identified less than 1 km north of the Colli dome. The deposits of unit O are dominated by wet and dry dilute and dense pyroclastic density currents (PDC) that rest on a paleosoil dated by the radiocarbon method at 6.4 ka BP. Detailed stratigraphic descriptions coupled with grain size, componentry, and whole-rock geochemistry revealed that the unit O is the youngest pyroclastic eruption of La Primavera and was originated from the Colli dome, the youngest volcanic structure of the Primavera caldera volcanic complex located in the northwestern outskirts of the densely populated metropolitan area of Guadalajara (5 million 268 inhabitants, INEGI 2020). The general abundance of dilute and dense PDCs, accretionary lapilli, and soft deformation of the wet dilute PDCs deposited suggest that magma-water interaction during the formation of the O pyroclastic eruption took place. Water source would be either, from the hydrothermal system of the caldera or from the local aquifer located at ~100 m depth.

ID: 103

Applying a Cost-Benefit Analysis method at a volcanic risk management plan in Latino-América: The case of the municipality of La Florida, Nariño, Colombia

Gustavo Cordoba[1], Antonio Costa[2], Diana Rodriguez[1]

[1] *Grupo de Investigación GRAMA, Facultad de Ingeniería, Universidad de Nariño, Colombia*

[2] *Istituto Nazionale di Geofisica e Vulcanologia - Sezione di Bologna, Bologna, Italy*

Cost-Benefit Analysis (CBA) is applied to the Municipality of La Florida, located at the slopes of Galeras volcano, Colombia. The municipality of La Florida supported our CBA approach in order to help them to stablish how many from the 588 households within the exclusion zone [AC1] should and can be relocated. The CBA concept is applied after performing a quantitative risk analysis. To that end, we assessed the probabilistic hazard of each of the main hazards of Galeras volcano, namely volcanic ballistics, PDCs, tephra fallout, lahar impact and burial, and shock waves. The vulnerability was estimated for three typologies of assets: infrastuctures??, humans, and Ecological Services. We found 3.958 structural exposed elements, 9.047 inhabitants, and land covert by natural forest, semi-natural areas and urban zones. The CBA criterion was based on the probabilistic threshold . The cost of no action (*L*) accounts for number of people at risk, the commercial cost of the household, and the cost of what the inhabitants stop producing in case of perishing by an eruptive event. The last one is estimated as 25 times the GDP, which for Colombia is about US$ 7.900, thus in average what an inhabitant in Colombia stop producing was about US$ 200.000. The replacement cost of a house in La Florida was around US$ 38.600, resulting in *L=US$469* million. The cost of replacement results in Cp=US$ 22.7 million. Thus, the probability threshold *Pu=0.05.* From this criterion, we recommend relocating only the 47 houses located at a Non-Tolerable Risk situation.

ID: 120

ESTRATIGRAFÍA Y REINTERPRETACIÓN DE LA ERUPCIÓN PLINIANA QUE DIO ORIGEN A LA "PÓMEZ CITLALTÉPETL", VOLCÁN PICO DE ORIZABA, MÉXICO

Matías N. Vásquez-Montoya[1], Rafael Torres-Orozco[2], José Luis Arce[3], Katrin Sieron[2], Francisco Córdoba-Montiel[2]

1 Programa de Maestría en Ciencias de la Tierra, Universidad Veracruzana, Xalapa-Veracruz, México.
2 Centro Ciencias de la Tierra, Universidad Veracruzana, Xalapa-Veracruz, México.
3 Instituto de Geología, Universidad Nacional Autónoma de México (UNAM), Ciudad de México, México.

El Pico de Orizaba o Citlaltépetl de ~650,000 años y 5,685 msnm es el estratovolcán andesítico activo más alto de Norteamérica, se localiza en el sector oriental de la Faja Volcánica Trans-Mexicana y está asociado a magmatismo de arco. Su actividad más reciente ocurrió en 1500-1600 CE y la última erupción Pliniana, la Pómez Citlaltépetl (PC), sucedió a principios del Holoceno. Mediante descripciones litoestratigráficas y mapeo en campo, fechamientos por C14, química y mineralogía, en este trabajo hemos determinado las edades de 8600 y 8250 BP para el inicio y final de este episodio eruptivo. La PC está formada por dos miembros (superior e inferior) de ~50 y ~20 cm de espesor, respectivamente. Los miembros están compuestos por clastos juveniles andesíticos, vesiculares y densos, separados por un paleosuelo de ~5 cm. La presencia de vesiculares bandeados sugiere un proceso de magma mingling en esta erupción. Ambos miembros fueron depositados por dos columnas eruptivas Plinianas distribuidas hacia el SE del cráter, acompañadas por corrientes piroclásticas de densidad (CPDs) concentradas y diluidas, secas y húmedas (colapso de domos y de columnas y actividad hidromagmática). Alrededor de 300,000 personas viven en las cercanías del volcán, en caso de un nuevo episodio eruptivo se verían amenazadas por los peligros de caídas piroclásticas y la gran variedad de CPDs identificados en este trabajo.

ID: 129

How syn-eruptive magma limestone interaction can increase the tephra fallout hazard

Marco Knuever[1], Daniela Mele[1], Roberto Sulpizio[1], Alessandro Pisello[2], Francesco Vetere[3], Antonio Costa[4], Diego Perugini[2]

[1] *Dipartimento di Scienze della Terra e Geoambientali, Università di Bari "Aldo Moro", Bari, Italy*

[2] *Dipartimento di Fisica e Geologia, Università di Perugia, Perugia, Italy*

[3] *Dipartimento di Scienze Fisiche, della Terra e dell'Ambiente, Università di Siena, Siena, Italy*

[4] *Istituto Nazionale di Geofisica e Vulcanologia (INGV) – Sezione di Bologna, Bologna, Italy*

Tephra and ash fall is one of the most direct hazards related to explosive volcanic activity. Both are primarily generated by the fragmentation of an ascending magma when the relative volatile overpressure cannot be further contained by the magma and the gas escapes by rupturing the magma.

Carbonate assimilation has been proposed in several studies to significantly alter eruptive style towards a more explosive eruptive behaviour due to the release of large quantities of CO_2 by the decomposing limestones. However, the timescales of CO_2-release during magma-limestone interaction have not been investigated thoroughly, especially in syn-eruptive and shallow near-surface settings. Here we present the results of a broad experimental study aimed at resolving the timescales of CO_2-release in function of many parameters like magma composition and viscosity, temperature, limestone composition and clast size. Our results indicate a syn-eruptive nature of the CO_2-release even in shallow near-surface settings concordant with magma ascent times.

Magma-limestone interactions are documented at various depths at many volcanic systems all around the world, including Somma-Vesuvius (Italy), Merapi, Kelud (both Indonesia), Popocatepetl (Mexico) and Pacaya (Guatemala). Hence, at those volcanoes an increased risk of tephra and ash fall out hazards to the inhabited areas proximal to the volcanic centres (e.g., Naples in case of Vesuvius) needs to be considered.

ID: 147

The Khonkho tephra and its implications for the rise of Tiwanaku and distal ashfall hazards in the Central Andes

Chris Harpel[1], Erik Marsh[2], David Damby[3], Luis Melendes[4]

[1]U.S. Geological Survey-USAID Volcano Disaster Assistance Program, Cascades Volcano Observatory, Vancouver, Washington, USA; [2]Laboratorio de Paleoecología Humana, Instituto Interdisciplinario de Ciencias Básicas, Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Mendoza, Argentina; [3]Volcano Science Center, U.S. Geological Survey, Menlo Park, California, USA; [4]Qhunqhu Liquiliqui Community, Qhunqhu Liquiliqui, Jesús de Machaca, Bolivia

We describe the informally named Khonkho tephra, which was deposited in the southern Lake Titicaca Basin (LTB), Bolivia by a previously unrecognized eruption sometime between 400 and 700 CE. These centuries were characterized by resettlement and migration from outlying villages to Tiwanaku leading to the rise of one of the Andes' first large, complex societies. The Khonkho tephra has not been previously described, nor have archaeologists working in the LTB considered the cultural impacts of volcanic eruptions, likely because the nearest Holocene volcanoes are hundreds of kilometers away. We characterize samples of this tephra from the archaeological site Khonkho Wankane. Published excavation accounts from other archaeological sites report similar deposits without conclusively identifying them as tephra. We suggest that the Khonkho tephra is present at these sites and impacted a wide region. The tephra's thickness, grain size, and geochemistry imply a large-magnitude explosive eruption at a Central Andean volcano, though its source remains elusive. Such a future eruption could have devastating regional impacts, including crop destruction, interruption of grazing, and contamination of water sources. Even minor disruptions of these resources could result in severe consequences for people living in this high-elevation, arid environment, and should be considered when tephra crop out in regional archaeological sites. The Khonkho tephra further demonstrates that the LTB could be severely impacted by ashfall, emphasizing the need for continuing documentation of Central Andean eruptions to characterize their frequency, magnitude, and distribution of their deposits. In doing so, we can better assess distal ashfall hazards regionally.

ID: 150

The ~5 ka Jamapa Pyroclastic Flow, an example of magma mixing triggering eruption at Citlaltépetl volcano, eastern Trans-Mexican Volcanic Belt

José Luis Arce (1), Mireya González (2), José Luis Macías (3), Rafael Torres-Orozco (4, 5)

(1) Instituto de Geología, Universidad Nacional Autónoma de México, Ciudad de México, México |(2) Escuela Superior de Ingeniería y Arquitectura, Ticomán, Instituto Politécnico Nacional, Ciudad de México,|(3) Instituto de Geofísica, Universidad Nacional Autónoma de México, Antigua Carretera a Pátzcuaro 8701, Morelia, Michoacán, México, (4) Centro de Ciencias de la Tierra, Universidad Veracruzana, Xalapa, México, (5) Observatorio Sismológico y Vulcanológico de Veracruz, Universidad Veracruzana, Xalapa, México.

Citlaltépetl (Pico de Orizaba) is the highest volcano (5675 masl) in Mexico and North America and is located at the eastern of the Trans-Mexican Volcanic Belt. The volcano records scarce SO_2 emissions, sulfur precipitations, and frequent volcano-tectonic earthquakes. Citlaltépetl has recorded at least eight explosive and four effusive eruptions in the Holocene. One of these, occurred ~5 ka ago with the emplacement of a dense PDC's, the Jamapa Pyroclastic flow (JPF), dispersed up to 3.6 km on the northern volcano flanks (1 m thick) consisting of subrounded to rounded blocks with porphyritic clasts of dacitic pumice (64 wt. % of SiO_2), andesitic scoria (59 wt. % of SiO_2), banded vesicular clasts, and andesitic dense blocks (62 wt. % SiO_2). The pumice contains plg + opx + cpx +/- amph phenocrysts, whilst the scoria contains opx + cpx + amph + plag +/- Fe-Ti oxides. Plg rims vary from An_{30}-An_{50} and An_{30}-An_{80}, in pumice and scoria respectively. Pyroxene records different temperatures (912ºC for pumice and 1014°C for scoria) and pressures (200 MPa to 900 MPa), while matrix glass varies from dacite to rhyolite. All these characteristics suggest that a hotter and more mafic magma reached the colder resident dacitic magma reservoir. Mixing of both magmas produced overpressure of the system followed by the explosive activity. Magma mixing is a common process in Citlaltépetl's eruptive history (e.g., Citlaltépetl Pumice). A future reactivation may generate PDCs that would represent serious hazards for the neighboring densely populated areas.

ID: 194

Using ash aggregates to constrain the timing of pyroclastic density currents during the April 2021 eruption of Soufriere, St Vincent

Cole P.D.[1] , Halls A,[1], Barclay J.[2] Robertson R.E.A[3],

[1]School of Geography Earth and Environmental Sciences, Plymouth University, Drakes Circus, Plymouth, PL4 8AA, UK,

[2]School of Environmental Sciences, University of East Anglia, Norwich, NR4 7TJ, UK

[3] University of West Indies Seismic Research Centre, St. Augustine, Trinidad & Tobago, West Indies

Constraining the timing of pyroclastic density currents (PDCs) associated with explosive eruptions is vital for effective hazard assessment.

The Aprll 2021 explosive eruption of La Soufriere St Vincent, a small VEI 4 event, lasted two weeks and, after an initial explosion on the morning of 9th April, became semi continuous for ~48 hours, comprising numerous closely spaced explosions with eruption columns ~ 15km high. Both dilute and dense PDCs occurred during the eruption, extending out of the crater from west to southeast and were formed by column collapse associated with several explosions.

Although PDCs were not formed until during initial phases of explosive activity, dense PDCs extended to the sea in two valleys: the Larikai and Roseau, draining the lowest part of the crater rim, 3.2 and 4.2 km from the Summit crater rim respectively.

Extensive ashfall after the initial explosions reduced visibility, making observations of PDCs impossible, thus restricting the precise timing of the onset of these hazardous phenomena.

A range of types of ash aggregates occur both within fallout and PDC deposits. Aggregates within dilute PDC or co-PDC fallout are dominated by multi-rim types with greater rim thicknesses and allows the timing of the onset of PDCs to be more tightly constrained within the tephra fallout sequence. Similar studies on the products of prehistoric eruptions might allow the timing of PDC generation to be pinpointed, where this information would otherwise be unavailable.

ID: 195

Unravelling the dynamics and hazards of the June 3rd, 2018, pyroclastic density currents at Fuego volcano (Guatemala)

Sylvain J. Charbonnier[1], Lizzette A. Rodríguez[2], Karla Ayala[2], Sahira Cancel[3], Rudiger Escobar-Wolf[4], Gustavo Chigna[5], Carla Chun-Quinillo[6], Dulce Gonzalez[6], William Chigna[7], Kevin Chun-Quinillo[5], Roberto Merida[5], Francisco Juarez[8], Eliza S. Calder[9]

[1]*School of Geosciences, University of South Florida, Tampa, United States*
[2]*University of Puerto Rico – Mayagüez Campus, Mayagüez, Puerto Rico*
[3]*Michigan State University, East Lansing, United States*
[4]*Michigan Technological University, Houghton, United States*
[5]*Instituto Nacional de Sismología, Vulcanología, Meteorología e Hidrología (INSIVUMEH), Edificio Central, 7a Avenida 14-57, zona 13, Ciudad de Guatemala, Guatemala*
[6]*Universidad Mariano Galvez, Guatemala*
[7]*Unidad de Volcans, Coordinadora Nacional para la Reduccion de Desastres (CONRED), Avenida Hincapie 21-72, zone 13, Ciudad de Guatemala, Guatemala*
[8]*Ministerio de Energia y Minas, 24 calle 21-12, zona 12, Ciudad de Guatemala, Guatemala*
[9]*School of Geosciences, University of Edinburgh, Edinburgh, UK*

The June 3rd, 2018, eruption of Fuego volcano (Guatemala) produced a complex sequence of small-volume pyroclastic density currents (PDCs) that inundated all sectors around the volcano and propagated >12 km on the southeastern flank, deposited ~50 million m^3 of pyroclastic material, and killed several hundred people. This eruption has illustrated once again that the behavior of small-volume PDCs remains difficult to predict, demonstrating the need for an improved understanding of their internal dynamics and hazard assessment.

In this work, we present the results of a multi-faceted study of the 2018 PDC deposits, including a reconstruction of the sequence of events on June 3rd with a conceptual model of PDC generation and emplacement on the SE flank of Fuego. In this model, a sequence of packages of material involved in discrete failure events of a perched mass of pyroclastic material accumulated within an old collapse structure on the upper SE flank, corresponds to the emplacement of a series of pulses of valley-confined PDCs down the Las Lajas channel. The lack of strong changes in the grain size distributions of the fine sub-populations inside the seven valley-confined PDC lobate front units imply the presence of a self-limiting attrition process, decreasing the bulk porosity of such long-runout BAFs and lowering their effective friction coefficient during transport. This multi-faceted approach completes previous studies already performed on small-volume PDCs at other volcanoes and opens a unique perspective that will provide a significant step forward in our understanding of how such currents are emplaced.

ID: 206

New evidence of the Upper Pleistocene directed blast, Popocatepetl volcano, México

R. Marcela Lira-Beltrán[1], Lizeth Caballero García[2,3], Delphine Sourisseau[3], Gerardo Ruíz[1], Geoffrey A. Lerner[4]

[1.] Departamento de Física, Facultad de Ciencias, Universidad Nacional Autónoma de México, Ciudad de México.

[2.] Escuela Nacional de Ciencias de la Tierra, Universidad Nacional Autónoma de México, Ciudad de México.

[3.] Instituto de Geología, Universidad Nacional Autónoma de México, Ciudad de México.

[4.] Earth Observatory of Singapore, Nanyang Technological University, Singapore.

The modern volcanic edifice of Popocatépetl is built on the remains of ancient volcanic structures that were partially destroyed by a Bezymianny or Mt. St. Helens-type sector collapse/directed blast eruption. The last strong eruption related to a collapse of the volcanic edifice occurred about 23,500 ka BP, which extended to the SW. It produced large debris avalanche deposits, deposits related to a directed blast, ashfall deposits and lava flows. The objective of the present work is to study in detail the blast-related deposits and to provide new data on their distribution in the S-SW sector of the volcano. Volcanic eruptions of the directed blast type can affect areas of hundreds of km^2 and reach a distance of more than 25 km from the crater. These directed eruptions are characterized by powerful explosions with a significant lateral component that travel at speeds above 100 m/s, which includes catastrophic high-energy pyroclastic density currents. The area studied is located between the municipalities of Ecatzingo and Atzitzihuacán, where 58,870 inhabitants live. To date we have visited 156 localities where we made descriptions of the eruptive sequence and stratigraphic sections. Within these localities, we found 42 new sites where the blast deposit outcrops. In the Barranca San Juan Amecac in the state of Puebla, the blast deposit is more than 20 m thick. With the new data we have estimated the dispersion area of the directed blast to be approximately 338 km^2. The most distal deposit we have located is 25 km from the volcano.

ID: 223

Relationship between lava length and lava volume

Takafumi Marusihi, Tomofumi Kozono, Eisuke Fujita

National Research Institute for Earth Science and Disaster Resilience

Hazard assessment of volcanoes requires an accurate prediction of the lengths of lava flows from the vents. The fundamental question is how the length of lava flow depends on the erupted volume and the effusion rate of lava flow. Malin (1980) predicts that basaltic lava flows in Hawaii obey a relationship of $L \propto V^{0.5}$ and have no correlation between L and Q. Here, L is the maximum length from the vent, V is the erupted volume, and Q is the effusion rate. We study the range of applicability for those relationships and the underlying physical mechanism, which have remained unclear. First, we recompile L and V from the literature documenting basaltic lava flows in Hawaii, Japan, Iceland, and Colombia. Our recompiled data reveals that all the basaltic lava flows universally obey the relationship of $L \propto V^{0.5}$. The relationship holds for V ranging from 10^5 m^3 to 10^{13} m^3 with deviations up to 30 times in L. Second, we conduct numerical simulations of an isothermal Bingham fluid as a simplified model of lava flow. Released from a hole on an inclined plane, the Bingham fluid flows down by gravity and finally stops due to its yield stress. Our numerical results yield a relationship of $L \propto V^{0.8}$ and independency of L on Q. These results align with the relationship of $L \propto V^{0.5}$ and the lack of correlation between L and Q in actual basaltic lava flows.

ID: 246

Erupción Morfo Azul: una nueva perspectiva de las implicaciones de la amenaza del volcán de Santa Ana en El Salvador.

Dennis Ulises Lemus Flores[1]

Christopher Harpel[2]

Angela Valeria García Lara[1]

Jacqueline Yamileth Rivera Ayala[1]

[1]Observatorio de Amenazas y Recursos Naturales de El Salvador, Ministerio de Medio Ambiente y Recursos Naturales (MARN).

[2]Volcano Disaster Assistance Program United State Geological Survey, Cascade Volcano Observatory (USGS/USAID)

Trabajando en el campo durante 2020 y 2023, hemos documentado una erupción potente del volcán de Santa Ana ocurrida hace más de 7,750 cal yr BP que ha cambiado nuestra perspectiva de los peligros asociados a este volcán. La erupción, que nombramos informalmente Morfo Azul, produjo una caída de tefra y corrientes de densidad piroclásticas (CDPs) depositadas en los flancos este y norte del volcán. Los depósitos de CDPs tienen espesores mayores de 2.1 m a una distancia de 1.4 km del cráter, y están hasta 4.4 km del cráter con espesores mayores de 0.8 m. El depósito de caída de tefra tiene un espesor de 3.2 m a 4.4 km del cráter y tiene una amplia distribución con un eje al norte o noreste. Tales depósitos implicarían preliminarmente un IEV 4–5, el IEV más grande conocido del volcán. Las CDPs y las caídas de tefra han sido encontradas en importantes zonas de cultivo de café y frutas, y en redes de drenaje que van hacia la zona baja, en el lago de Coatepeque, donde hay comunidades y actividad turística. Estos depósitos se encuentran en 8 comunidades en los alrededores del volcán, con una población aproximada de 7,000 personas. Una erupción similar en la actualidad, considerando el alcance que pueden tener las CDPs y los espesores de caída de tefra, causaría impactos severos en las áreas agrícolas, en infraestructura de viviendas y caminos, en actividades económicas, como el turismo, y en los servicios públicos de esas comunidades.

ID: 263

Lessons from ash: a review on traces of fragmentation retrieved from pyroclasts at arc volcanoes

Natalia Pardo

Departamento de Geociencias, Universidad de Los Andes, Bogotá, D.C.

Fragmentation mechanisms are commonly retrieved from fine to very fine ash componentry and juvenile glassy ash morphology. However, the identification of juvenile clasts is not always straightforward and requires cautions analyses with multiple techniques. Moreover, theoretical concepts, mostly retrieved from experiments, have been well studied for low-viscosity magmas but are quite challenging for understanding high-viscosity magmas of complex rheology. Here, I present a synthesis of the state of art on clues revealed by natural pyroclasts on fragmentation at silicic volcanic arc systems. In general, the complexity of explosive magma-water interaction, magma decompression and degassing paths is attested by the variety of juvenile particles' morphologies, textures and chemistry. A variety of studies reveal that multiple and combined fragmentation mechanisms may act simultaneously on different magma portions, depending on decompression rate, stage/style of degassing, and the degree of interaction with the external water. The degree of bulk and glass chemistry, morphology and textural variability of juvenile fragments suggest a feedback mechanism between internal and external processes in the volcanic system, altering the velocity profile within the conduit, and favouring complex viscous flow before fragmentation. Here, I will sumarize lessons learned over the past few decades on pyroclasts ejected at composite volcanoes providing diagnostic information on fragmentation mechanisms expected in subduction zones.

ID: 314

Comparison of physical parameters of three lava fountain episodes on Etna volcano within the 2021 paroxysmal sequence

Daniele Andronico[1], Antonio Cristaldi[1], Mattia de' Michieli Vitturi[2], Ferruccio Ferrari[1], Federica Pardini[2], Gregoire Pasdeloup[3], Pierre-Simon Ross[3]

[1]Istituto Nazionale di Geofisica e Vulcanologia, Osservatorio Etneo, Sezione di Catania, Catania, Italy; [2]Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Pisa, Pisa, Italy; [3]Institut national de la recherche scientifique, Québec City, Canada

Between February 16 and April 1st, 2021, 17 paroxysmal episodes occurred at the South-East Crater (SEC) of Etna volcano. The lava fountains and eruptive columns that rose above the SEC were on average more intense and higher than those observed in the >300 paroxysms that occurred during the previous 30 years. Three episodes of the sequence with dissimilar volcanological characteristics were selected and studied: a) the February 16 episode, which opens the 2021 sequence and is characterized by an unexpectedly fast dynamic, with a dense eruption column and discharge of coarse-grained tephra up to the city of Catania 27 km from the crater; b) the February 28 episode, forming an unusual high-mass-loaded fallout deposit about 10 km from the SEC; and c) the March 4 episode, for which we sampled tephra over tens of km from the vents. For each episode, we describe the eruption chronology based on seismic tremor and video-surveillance recordings, as well as reconstructed dispersal, total grain-size distribution and total mass of the fallout deposits. Finally, using the estimated physical parameters of individual episodes, we performed numerical simulations to reproduce column heights and fallout deposits. The results allowed us to quantitatively compare similarities and differences between three lava fountain episodes within the same sequence and, ultimately, improve our knowledge of the explosive processes during paroxysmal activity on Etna.

ID: 339

Shape parameter measurements of tephra samples from grayscale images of individual particles using Dynamic Image Analysis

Kosei TAKISHITA[1], Takahiro MIWA[1], Masashi NAGAI[1], Setsuya NAKADA[1], Takehiko SUZUKI[2]

[1]National Research Institute for Earth Science and Disaster Resilience (NIED), Tsukuba, Japan; [2]Tokyo Metropolitan University (TMU), Hachioji, Japan

The shape consideration of tephra particles leads to an accurate tephra dispersion modeling. Dynamic Image Analysis (DIA) is effective for precise shape estimation. Conventional instruments have two limitations: treating binary images and outputting only the distribution of each parameter (e.g. Buckland et al., 2021). Here, we used an instrument improving those limitations to analyze 4 tephra samples and investigated the potential to distinguish extremely-shaped particles. The Microtrac MRB Sync instrument, used in this study, measures the particle diameter and shape parameters of individual particles from grayscale images using DIA. The tephra samples used were AT (rich in tabular particles), DKP (rich in cylindrical particles), U-Oki (rich in pumice particles), and Sakurajima (from an eruption in 2021, rich in blocky particles). The parameters examined here are area-equivalent diameter d_{eq}, aspect ratio L/W, and transparency Tp. In all samples, d_{eq} and Tp has a strong inverse correlation. The AT tephra with size of > 4ϕ shows extremely high Tp. Also, the maximum L/W (approx. 8) is highest in the AT tephra for size of 3ϕ-4ϕ. As the AT tephra is rich in tabular particles, we can infer that Tp and L/W shows low and high values when the shortest axis of particle is vertical and parallel to the projection plane, respectively. Thus, we conclude that the d_{eq}-Tp and d_{eq}-L/W distribution can be useful to distinguish tabular particles. The DIA method employed in this study is expected to obtain new insights from further tephra analysis.

ID: 375

Eruptive styles and magma fragmentation at Cinder Cone, Lassen, California: insights from juvenile ash

Grégoire Pasdeloup[1], Pierre-Simon Ross[1], Kristina Walowski[2]

[1]Institut National de la Recherche Scientifique, 490 rue de la Couronne, Québec (QC), G1K9A9, Canada;
[2]Department of Geology, Western Washington University, Bellingham WA 98225, USA

Scoria cones, although described as the simplest volcanic edifices, can have a range of eruptive styles. Further, the details of magma fragmentation in basaltic explosive eruptions are incompletely understood. Magma fragmentation is recorded in the juvenile ash found in tephra fallout sheets around the cones. But to compare ash from different volcanoes, a standardized methodology is required. Here, we use the protocol established by Comida et al. (2022) and Ross et al. (2022) in Bulletin of Volcanology in a comparative study of multiple scoria cones. Our first study site is Cinder Cone, located in Lassen Volcanic National Park, California, in the Cascades Arc. The eruption occurred around 1666 CE, and the eruptive style apparently changed from Hawaiian/Strombolian to violent Strombolian during three different phases (Clynne & Muffler, 2010; Walowski et al., 2019).

In summer 2022, we sampled pyroclastic deposits along the dispersal axis, from proximal to medial-distal locations. Two main packages, layers 2 and 3 of Heiken (1978), were observed. 26 samples were manually sieved with half-phi intervals. We obtained componentry for three size fractions (5.7-4 mm, 0.71-0.5 mm and 88-63 µm) to observe differences between sampling sites and between eruption units. Using only ash-sized juvenile clasts, we measured morphometry, internal textures (vesicularity, crystallinity), and surface features from SEM analyses. Layer 2 is slightly coarser-grained and contains more golden pumice, whereas layer 3 contains more angular dark fragments. These results will be compared to the inferred eruptive history of the volcano, and also with other well known scoria cone eruptions.

ID: 420

Shape-size dependence of in-flight volcanic bombs

A Sork[1]; B Kennedy[1]; R Fitzgerald[2]; L Watson[1]; J Taddeucci[3]; M Sellier[1]; C Biensan[3]; P Scarlato[3]; D Andronico[4]; T Ricci[3]

[1]University of Canterbury, Christchurch, New Zealand; [2]GNS Science, Lower Hutt, New Zealand; [3]Istituto Nazionale di Geofisica e Vulcanologia, Sezione Roma 1, Roma, Italy; [4]Istituto Nazionale di Geofisica e Vulcanologia, Osservatorio Etneo, Catania, Italy

A critical aspect of volcanic ballistic hazard assessment and forecasting is estimation of impact locations; this is generally accomplished using probabilistic ballistic hazard models that generate physics-based ballistic trajectories from a given range of input parameters. Drag is a significant, but understudied, factor in these models. For efficiency of calculation, many models allow input of a single drag coefficient, applied to all generated particles, or the selection of a single 'regular' shape (sphere, cube, etc.) with a known drag coefficient. It is questionable how well this assumption represents in-flight ballistics, especially molten ballistics (bombs) which tend to have complex and irregular shapes. Here we present and compare bomb shape distribution data, obtained from high-speed video datasets of a selection of eruptions.

In this study, we define end-member shapes for bombs and analyse their proportional distribution within different eruption pulses. While individual bombs vary largely in shape, we show that across several different eruptions the net shape distribution is consistent and has a strong size dependence. The overwhelming majority of small (<0.16m) bombs are rounded, and the proportion of complex, non-rounded shapes increases with increasing size. Shape distributions are, however, insensitive to changes in eruption condition parameters such as pulse median ejection velocity. Most ballistic models already use size as an input, and our data suggest that size can be additionally leveraged to supply a shape-based drag coefficient within ballistic models, with the potential to better constrain modelled impact distributions.

ID: 503

Comprehensive analysis of Strombolian explosion parameters using high-frequency, thermal, UV, visual, and acoustic time series data

Elisabetta Del Bello[1], Emanuela Bagnato[2], Laura Spina[1], Giancarlo Tamburello[3], Jacopo Taddeucci[1],Tullio Ricci[1], Piergiorgio Scarlato[1], Daniele Andronico[4], Francesco Pennacchia[1]

[1]*Istituto Nazionale di Geofisica e Vulcanologia, sezione di Roma 1, Roma, Italy;*

[2]*Istituto Nazionale di Geofisica e Vulcanologia, Osservatorio Vesuviano, Napoli, Italy;*

[3]*Istituto Nazionale di Geofisica e Vulcanologia, sezione di Bologna, Bologna, Italy;*

[4]*Istituto Nazionale di Geofisica e Vulcanologia, Osservatorio Etneo, Catania, Italy;*

Stromboli volcano provides a unique opportunity to investigate dynamic volcanic processes by employing a variety of techniques, including thermal, UV and visible imagery, and acoustic signals. These combined methods allow for the frequent monitoring of volcanic phenomena, offering valuable insights into rapid processes like Strombolian explosions and enabling the quantification of several parameters, such as gas and pyroclast flow rates, explosion characteristics, and energy output.

During three specific periods, May 2019, October 2020 and May 2021, we conducted comprehensive, high-frequency, multi-parameter measurements. Daily, we collected 2-5 hours of continuous time series data, including UV, thermal infrared, visible imagery, and acoustic information. UV images measured SO2 emissions perpendicular to the plume's path, thermal analysis tracked temperature changes during explosions, and combined with visual data to monitor plume and pyroclast ejection speeds, and acoustic signals were assessed for spectral properties related to eruptive styles. Wavelet analysis of select events provided insights into volcanic jet behavior.

Integrating and analyzing these datasets allowed us to identify various active degassing patterns at the summit vents and distinguish between observed activity styles. Notably, a correlation between thermal and SO2 signals was observed, particularly at the start of each explosion. In some cases, we determined the mean masses and fluxes specific to individual explosions. The high data acquisition rate enabled us to derive more precise quantitative eruption parameters compared to traditional low-frequency methods, further validated through independent estimation techniques.

ID: 513

Monitoring volcanoes of the world with IMS infrasound network: evaluation of the reliability of a new detection algorithm

Duccio Gheri[1,2], Emanuele Marchetti[1] , Giacomo Belli[1]

[1]*University of Florence, Earth Science Department*

[2]*Univeristy of Pisa, Earth Science Department*

Detecting and promptly notifying ongoing volcanic eruptions is crucial in supporting Volcanic Ash Advisory Centers. Nevertheless, many active volcanoes lack local monitoring systems. Long-range infrasound monitoring, which holds the potential to detect and notify volcanic explosive events, could offer valuable insights. Numerous studies have already emphasized the utility of long-range infrasound for this purpose, but questions regarding its actual effectiveness and reliability persist.

In this research, we delve into the capabilities of the International Monitoring System (IMS) infrasound network managed by the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) in remotely detecting volcanic explosive eruptions. Our focus is on the most active volcanic regions during the period from 2010 to 2019, encompassing multiple eruptions that ranged in energy from mild explosions to those classified as VEI (Volcanic Explosivity Index) ≥ 4.

We exploited a detection algorithm originally developed for local applications by adapting it to long-range volcanic infrasound observations. To evaluate the algorithm's reliability, we compared the provided notifications with reports from the Global Volcanism Program (GVP). Despite unresolved ambiguity remains due to short spacing among volcanoes with respect to the array and the unfavourable infrasound propagation conditions, our algorithm has demonstrated its ability to detect ongoing volcanic activity in near real-time with a high degree of notification reliability.

ID: 517

The long and winding fragmentation of mafic magmas

J. Taddeucci[1], C. Cimarelli[2], M. Manga[3], P. Scarlato[1]

[1]Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy; [2]Department of Earth and Environmental Sciences, Ludwig-Maximilians-Universität, Munich, Germany; [3]Department of Earth and Planetary Science, University of California, Berkeley, USA.

Magma fragmentation is a key driver of explosive volcanic eruptions. Fragmentation is often simplified as a single process occurring at some well-defined interval in time and space (e.g., the often-invoked 'fragmentation depth'), but mounting experimental, observational, and textural evidence is now uncovering a more complex picture. Here we present an ensemble of textural evidence from mafic pyroclasts illustrating the complexity of magma fragmentation during a range of explosive activities. Angular to smooth contours of pyroclasts from the same deposit indicate fragmentation both before and after quenching, with transitional features at the fragile-viscous boundary also occurring. Multiple fragmentation events are revealed by the incorporation and re-fragmentation of pyroclast-in-pyroclast. Broken crystals within intact glass reveal the passage of brittle cracks through the magma and their subsequent viscous healing, ultimately affecting the grain size distribution of eruption products. EBSD results show limited misalignment in the lattice of broken crystals, and large (up to 10°) misalignment in unbroken but bent ones, suggesting stress accumulation in the magma (and crystals) and its release by cracks. Micro-XCT reveals cracks with complex morphologies and almost ubiquitous connections with vesicles. Observations highlight the presence of 'damage zones' in pyroclasts, formed in narrow areas of a locally stressed and already vesicular magma at temperatures relatively close to quenching. All these evidences point to a prolonged, spatially and temporally heterogeneous development of magma fragmentation from early vesiculation at depth to post-eruption in the atmosphere.

ID: 525

Constraining eruption parameters and environmental impacts using remote sensing observations of forest disturbance and recovery.

Megan Udy[1], Susanna Ebmeier[1], Sebastian Watt[2], Andy Hooper[1], Iain Woodhouse[3]

[1]School of Earth and Environment, University of Leeds, Leeds, UK; [2]School of Geography, Earth and Environmental sciences, University of Birmingham, Birmingham, UK; [3]School of Geosciences, The University of Edinburgh, Edinburgh, UK

Forest disturbance resulting from explosive volcanic eruptions ranges from total destruction and burial of vegetated landscapes to minor/temporary damage. While eruptions that damage vegetation over 100s of kilometres are rare, some volcanoes regularly impact local vegetation, with frequencies of months to decades. The extent and style of damage reflects intensity and mechanism of the driving volcanic process, while timescales and patterns of regrowth reflect the nature of initial impacts and local floral, climatic and environmental parameters. As such, vegetation damage holds potential as a novel proxy for the magnitude and nature of explosive volcanic eruptions, potentially constraining parameters such as tephra-fall deposit thickness, dispersal and pyroclastic density currents (PDC) distribution. Using optical and radar satellite data to study forest disturbance and recovery following the 2015 explosive volcanic eruption of Calbuco in Southern Chile, we develop a method to constrain eruption magnitude, dispersal patterns and to understand timescales and patterns of forest recovery.

The eruption produced large buoyant ash plumes depositing tephra over 100s km^2, pyroclastic flows extending 6km and lahars extending 15km. This damaged the temperate broadleaf forests with a gradational pattern ranging from total destruction and burial through to abrasion damage and foliage stripping. Our satellite based methodology demonstrates systematic patterns in the extent of damage and in forest recovery timescales, which correlates closely to known eruption impacts and dispersal directions. As a result, we are able to improve the mapping of tephra dispersal and initial impacts, and constrain the persistence of the eruption footprint on the damaged forest.

ID: 537

Constraining the eruption history of the Canary Islands and Azores using distal marine cores

Danielle McLean[1], Emma Horn[1], Simone Aguiar[2], Nick Barton[1], Stacy Carolin[1], Holger Kuhlmann[3], José MR. Pacheco[2], Adriano Pimentel[2], Amy Styring[1], Kevin Uno[4], Heather Upton[1], Yunbei Xu[1], Victoria C Smith[1]

[1]School of Archaeology, University of Oxford, Oxford, UK; [2]IVAR - Instituto de Investigação em Vulcanologia e Avaliação de Riscos, Azores, Portugal; [3]MARUM - Center for Marine Environmental Sciences, Bremen University, Bremen, Germany; [4]Department of Human Evolutionary Biology, Harvard University, Massachusetts, US

Constructing accurate eruption histories for volcanic islands is notoriously difficult, and often hampered by the limited proximal exposures, high erosion rates, and the fact that the majority of pyroclastics are deposited into the surrounding ocean. However, these records are essential to decipher the magnitude and frequency of past events, and thus critical for hazard assessments. Here, we present results from marine sediment cores obtained from the North Atlantic (including ODP 958) that resolve and precisely date eruptions from the Canary Islands and Azores spanning the last 200 ka. Many of these eruptions are preserved as non-visible (cryptotephra) layers in the sediments, and we have used their glass shard compositions (major and trace elements) to fingerprint the layers and pinpoint the volcanic source and particular eruption. This augmented tephrostratigraphy reveals that large magnitude events from the Canary Islands and Azores are more frequent and widely dispersed than anticipated. In addition to stratigraphically resolving closely spaced eruptions for the first time, the extent of distal ash fall is revealed. Using this new record, we simulate ash distributions (via Ashfall3d) to estimate the eruption parameters required. This work also highlights the numerous widespread tephra layers that could be utilised as time-stratigraphic markers for correlating and dating other nearby sedimentary records, including archaeological sites in North Africa.

ID: 545

Costa Rica: a remarkable laboratory for the study of hydrothermal eruptions and slope stability

Geoffroy Avard[1], Bryan Moncada Villegas[2], Michael J. Heap[3], Patrick Baud[3]

[1]Observatory of Volcanology and Seismology of Costa Rica (OVSICORI), Universidad Nacional (UNA), Heredia, Costa Rica; [2]Department of Physics, Universidad Nacional (UNA), Heredia, Costa Rica; [3]School and Observatory of Earth Sciences (EOST), Strasbourg, France

The most common explosive activity on volcanoes is dominated by its hydrothermal component, particularly in humid regions. During the last decades, the difficulty to predict phreatic dominant eruptions led to the main human loss on volcanoes (Ontake, Japan, 2014; Whakaari, New Zealand, 2019). With several hundreds of phreatic eruptions annually, Costa Rica is an ideal place to study such phenomena. Rincón de la Vieja and Poás volcanoes present large hydrothermal systems that interact with small magmatic inputs, generating frequent phreatic eruptions of diverse magnitudes.

Moderate to large phreatic eruptions usually present a small proportion of juvenile material in the ash, and bombs at diverse levels of alteration from solid blocks to very fragile agglomerates. These are fragments of the hydrothermal seal responsible for the explosive event. The alteration process generally reduces the permeability of the rock, and hence its ability to let the volatiles escape, generating sudden large gas expansion when the rupture of the partial seal decompresses the fluid. Chemical and physical characterization of these rocks is the first step to understand the fluid-rock interaction and its consequences, in terms of volcanic explosivity, and slope stability as medium to large landslides were also recently observed in Costa Rica coinciding with hydrothermal fields.

We focus here on the description of costarrican rocks found after moderate to large phreatic eruptions from Rincón de la Vieja and Poás volcanoes, and of the hydrothermal rocks found on the fracture zone of a large landslide on Platanar-Porvenir volcanic complex in 2023.

ID: 588

The impact of the 2021 eruption of Cumbre Vieja volcano (La Palma, Canary Islands) on the landscape: morphological changes and related hazards from UAS surveys

Riccardo Civico[1], Tullio Ricci[1], Ulrich Küppers[2], Markus Schmid[2], Victor Ortega-Ramos[3], Iván Cabrera-Pérez[3], Piergiorgio Scarlato[1], Luca D'Auria [3,4]

[1] Istituto Nazionale di Geofisica e Vulcanologia, Roma, Italy; [2] Department of Earth and Environmental Sciences, Ludwig-Maximilians-Universität (LMU), Munich, Germany; [3] Instituto Volcanológico de Canarias (INVOLCAN), 38400 Puerto de la Cruz, Tenerife, Canary Islands, SPAIN; [4] Instituto Tecnológico y de Energías Renovables (ITER), 38600 Granadilla de Abona, Tenerife, Spain

The 2021 eruption of Tajogaite cone (Cumbre Vieja ridge) is the largest historical eruption on La Palma Island. Over the course of almost 3 months, the volcano produced profound morphological changes in the landscape affecting both the natural and the anthropic environment over an area of tens of km^2.

Here we present the results of six UAS surveys (January 2022 to August 2023) coupled with Structure-from-Motion (SfM) photogrammetry that allowed us to produce high-resolution (up to 0.2 m/pixel) DSMs and orthophotomosaics (up to 0.1 m/pixel). We characterised the topography of the volcanic cone and documented its morphological evolution through time. Topographic change detection was performed by differencing our surveys and a pre-eruption surface, in order to detect elevation, volumetric, and areal variations. Among major morphological changes, we documented the dismantling of the volcanic edifice including episodes of gravitational collapse, growth and propagation of faults and fractures dissecting the new cone as well as the evolution of collapse structures in the lava field.

The identification and characterization of the abovementioned features are relevant for understanding volcanic edifice evolution and its stability, for the assessment of the hazards related to tourist frequentation, and for the safety of the personnel involved in the monitoring activities.

ID: 612

Increased volcanic risk at Stromboli

Tullio Ricci[1], Riccardo Civico[1], Piergiorgio Scarlato[1], Daniele Andronico[2], Massimo Cantarero[2], Emanuela De Beni[2], Elisabetta Del Bello[1], Ulrich Kueppers[3], Markus Schmid[3], Jacopo Taddeucci[1]

[1]Istituto Nazionale di Geofisica e Vulcanologia, Roma, Italy; [2]Istituto Nazionale di Geofisica e Vulcanologia, Osservatorio Etneo, Catania, Italy; [3]Department of Earth and Environmental Sciences, Ludwig-Maximilians-Universität (LMU), Munich, Germany

Volcanic hazard assessment at active volcanoes requires repeated surveys to establish a robust baseline and reveal status variations. At Stromboli (Italy), ground-based morphological surveys have been aided by UASs revealing a plethora of new details. Until 2019, in periods of ordinary Strombolian activity, slope collapse events did not pose a significant hazard for the sea sector offshore Sciara del Fuoco (SdF). On 3 July and 28 August 2019, two paroxysmal eruptions abruptly changed the morphology of the entire crater terrace thus facilitating the opening of new vents on the steep slope of the NE crater, the piling-up of loose pyroclastic debris on the SdF, lava overflows and local collapse of those unstable vents. As a consequence, ordinary activity can now result in PDCs propagating offshore potentially triggering tsunami waves. Since March 2020, seven episodes of PDCs have been associated with both Strombolian activity and a major explosion. The high temporal frequency of UAS surveys after 3 July 2019 (>20 surveys) allowed us to investigate the evolution of the NE crater, involved in all the collapse episodes, and quantify the propensity for recurrent mass wasting events. Furthermore, on 25-26 May 2022 the NE sector of the island was affected by a human-ignited wildfire that created the conditions for secondary hazards like lahars. The first lahar was triggered by heavy rainfalls on 12 August 2022, and four other episodes occurred since then. Repeated UAS surveys permitted to identify the morphological changes in the affected sector.

ID: 627

Determination of Pozo del Carmen volcano (San Luis Potosí, Mexico) vent by using QTA methodology.

Rodríguez Sedano Luis Angel[1], Silva Rodríguez, Estefania Guadalupe[2], Sarocchi Damiano[2], Saucedo Ricardo[2], Alatorre Pineda, Amanda[2], Guerrero Hernández, Mayra[2], Calderón Coronado Leslie[2]

[1]CONAHCYT-Instituto de Geología, Universidad Autónoma de San Luis Potosí, Av. Dr. M. Nava No 5, Zona Universitaria, 78240, San Luis Potosí, México; [2]Instituto de Geología/Facultad de Ingeniería-UASLP, 78240, San Luis Potosí, México.

Pozo del Carmen (PC) is a monogenetic volcanic structure located in the municipality of Armadillo de los Infante, close to the city of San Luis Potosi, México. To date, it has not yet been possible to determine what type of volcanic structure PC is. According to field observations, evidence has been found suggesting that the volcanic activity in PC was an intercalation of magmatic and phreatomagmatic activity. In the present study we report results of the application of Quantitative Texture Analysis (QTA) focused on clast shape-fabric and granulometry. QTA is based on the analysis of three important parameters related to the particles arrangement: the particle size distribution or granulometry, the shape or individual morphology of the particles and the shape-fabric or the analysis of the spatial distribution of the particles in the deposit based on the orientation of its major axis. Clast shape-fabric reveals important information about the paleo flow directions and is therefore a useful tool to determine the provenance of volcaniclastic sediments, while granulometry reveals important information about the kinematics and flows transport conditions. More than 20 suitable outcrops were identified and more than 40 oriented samples were extracted for the granulometric and shape-fabric analysis. With this information have been possible to locate the posible area of the vent. This will help to understand the evolution of PC volcano, and laying the groundwork for a next step to determine what type of volcanic structure it is.

ID: 234

Algoritmo de detección por análisis de conglomerados de amplitud de ond

José Luis Méndez[1]

[1] *Instituto de investigación en ciencias naturales y tecnología -Iarna-, Universidad Rafael Landívar*

El método de detección de explosiones propuesto se basa principalmente en la técnica de conglomerados de datos. La técnica de conglomerados implica agrupar datos similares en función de sus características comunes. En este contexto, se aplica al análisis de la amplitud de las ondas sísmicas y acústicas. Cuando ocurre una explosión, las señales registradas presentan patrones característicos de amplitud que

El método de conglomerados de amplitud analiza estas características para identificar automáticamente las explosiones. Al hacerlo, no solo detecta las explosiones, sino que también establece automáticamente los límites temporales de un evento explosivo, lo que lo convierte en un enfoque altamente eficiente y autónomo.

Este enfoque mejora significativamente la capacidad de monitoreo continuo de la actividad volcánica.

En resumen, el método de conglomerados de amplitud representa una contribución valiosa al campo de la vulcanología al permitir la detección automática de explosiones volcánicas con alta precisión y autonomía, lo que mejora significativamente la capacidad de predecir y gestionar el riesgo de desastres relacionados con volcanes.

ID: 266

Investigating Degassing and Crystallization Processes in Magmatic Ascent: Insights into Precursory Signals at Campi Flegrei Caldera

Lucia Pappalardo [1,*], Carolina Baccari [1, 2], Gianmarco Buono[1], Mauro Antonio Di Vito[1], & Paola Petrosino[2].

[1] Istituto Nazionale di Geofisica e Vulcanologia, Osservatorio Vesuviano, Naples, Italy
[2] Dipartimento di Scienze della Terra, dell'Ambiente e delle Risorse (Distar), University of Naples Federico II, Naples, Italy;

The presented study investigates the degassing and crystallization processes occurring during magma ascent within the volcanic conduit. This information provides valuable insights into the spatiotemporal evolution of geophysical and geochemical precursors preceding magmatic unrests . The Campi Flegrei caldera (CF) stands out as a highly dangerous volcano in Europe, currently undergoing a phase of ongoing unrest since 2005. The precise origin of this unrest remains a topic of debate in the literature, making CF an exemplary case study.

In this research, eruptions of diverse Volcanic Explosivity Index, varying ages, and vent locations within the caldera were selected. These include Baia Fondi di Baia, Averno, Monte Nuovo (in the western sector), Astroni-Senga, Pomici Principali, and Agnano Monte Spina (in the central-eastern sector). The study focuses on comprehensive sampling and detailed geochemical and textural analysis of representative products from various phases of the selected eruptions, encompassing both magmatic and phreatomagmatic phases. Particular attention is directed towards the initial phases, which offer pivotal insights into the volcanic conduit's opening processes, indicative timeframes, and the manifestation of early precursory signals.

The results obtained from this study hold paramount significance in the formulation of plausible pre-eruptive scenarios and their association with the spatiotemporal evolution of unrest indicators, enhancing our ability to assess and comprehend volcanic hazards and associated risks.

ID: 368

Refining the marine tephrostratigraphy of the central Mediterranean (40-90 ka): New insights into Late-Pleistocene Campanian explosive volcanism

Molly Flynn[1], Paul Albert[1], Giada Fernandez[2], Victoria Smith[3], Christina Manning[4], Roberto Isaia[5], Sophie Vineberg[3], Sebastien Nomade[6], Patricia Richard[6].

[1]Swansea University, Singleton Park, Sketty, Swansea, SA2 8PP, UK; [2]Sapienza, Università di Roma, Piazzale Aldo Moro, 5, 00185 Roma RM, Italy; [3]University of Oxford, South Parks Road, Oxford, OX1 3TG, UK; [4]Royal Holloway, University of London, Egham, TW20 0EX, UK; [5]Osservatorio Vesuviano, INGV, Italy; [6]LSCE, Gif-Sur-Yvette, France.

Volcanic hazard assessments rely heavily on the investigation of tephra deposits preserved in near-source volcanic settings. However, these eruption records which provide insights into past explosive activity are often fragmentary due to burial and erosional processes, particularly problematic for older, low-to mid-intensity explosive eruptions, but that extends to larger magnitude events as well. This has major implications on forecasting future eruption scenarios. Fortunately, tephra deposits recovered from distal sedimentary archives can provide a long continuous ash-fall record and, therefore, provide a crucial tool for filling the gaps in long-term eruption records.

In this contribution, we examine tephra deposits preserved in Mediterranean marine sediment cores DED87-07 and DED87-08 (Tyrrhenian Sea) and MD909-16 (Adriatic Sea) to better constrain the timing, scale, and ash dispersal patterns of the densely populated Campanian volcanoes Ischia and Campi Flegrei (Southern Italy). A particular focus is better resolving the long-term eruptive history leading up to, during and following the caldera-forming Monte Epomeo Green Tuff (MEGT) eruption of Ischia. The islands near-source record is not extensively preserved on land, limiting our understanding of activity leading up to and during one of the largest Late Quaternary explosive eruptions of the central Mediterranean. Major (EMPA) and trace (LA-ICP-MS) element geochemical fingerprinting of the distal tephra's (glass) are integrated with near-source eruption records and combined with a new high-resolution oxygen isotope record (DED87-07) to present new tephrochronological and paleoclimate data which facilitates a refined eruption record for the central Mediterranean.

ID: 76

Dynamics and sedimentation from experimental plumes

Benjamin J. Andrews

Global Volcanism Program, National Museum of Natural History, Smithsonian Institution, Washington DC, United States

Volcanic eruption plumes transport and deposit ash for 100s to 1000s of kilometers. Suspended ash poses threats to aviation, and ashfall can present a hazard to life and property on the ground. Quantitative knowledge of ash plume transport and depositional processes is required for accurate eruption forecasting, hazard mitigation, and interpretation or analysis of ancient eruption deposits. Here we present results from a new experimental laboratory at Smithsonian designed to study analog volcanic plumes in a controlled atmosphere. Warm, turbulent, particle-laden plumes are generated in a chamber and then allowed to flow as gravity currents into a temperature-stratified (cool at base; hot at top), air-filled flume with a ~90-cm square cross-section and 11 m length. The plumes thus flow through the tank as neutrally-buoyant or penetrating density currents. We illuminate the experiments with laser sheets and film them with HD and high-speed video cameras. We measure the resulting deposits using an array of sediment samplers positioned on the tank floor. Temperature is logged at 30Hz using thermocouples. Flow velocimetry analysis shows that the spreading plumes often entrain or mix with the ambient atmosphere. Isomass maps of the deposit mass are best explained using a power law sedimentation model consistent with deposition from an entraining density current rather than an exponential model.

ID: 203

Assessing the impact of tephra fall on coffee production at Santa Ana volcano, El Salvador

Angela Valeria García Lara[1], Jacqueline Yamileth Rivera Ayala[1], Dennis Ulises Lemus Flores[1], Christopher J. Harpel[2], Sébastien Biass[3], Lucía Domínguez[3], Costanza Bonadona[3], Daniel Bertín[4,5], Kelly Jeaneth Godínez[6]

[1]Observatorio de Amenazas y Recursos Naturales de El Salvador, Ministerio de Medio Ambiente y Recursos Naturales, San Salvador, El Salvador; [2]Programa de Asistencia en Desastres de Volcanes del Servicio Geológico de Estados Unidos y USAID, Observatorio de Volcanes Cascades, Vancouver, Washington; [3]Departamento de Ciencias de la Tierra, Universidad de Ginebra, Suiza; [4]Servicio Nacional de Geología y Minería, Santiago, Chile; [5]The University of Auckland, Auckland, New Zealand; [6]Departamento de Física, Facultad Multidisciplinaria de Occidente, Universidad de El Salvador, Santa Ana, El Salvador

Santa Ana volcano (SAV) is an active, touristic volcano surrounded by coffee crops between 1,000 and 2,365 m above sea level in the Apaneca-Ilamatepec province. In 2005, a VEI 2 eruption generated a 10 km-high plume that dispersed tephra up to 40 km to the southeast of the vent. About 400 km^2 of coffee crops were affected with a total loss of 44 million US dollars, equivalent to about 20% of the annual national production. Major impacts were associated with acid water overflow from the crater onto the volcano's eastern flank and the subsequent acid rain and debris flows generated by Hurricane Stan. Although SAV's current tephra fall hazard maps were produced in 2004, one year before the eruption, they do not include scenarios of hydromagmatic activity, even when the stratigraphic record includes phreatic, hydromagmatic, and magmatic eruptions within the last 1,500 years. The aim of this study is to update the hazard maps to include a VEI 2 basaltic-andesitic hydromagmatic scenario to assess the impact of tephra fall on coffee production. We present here our results of probabilistic hazard modelling using the TephraProb program based on eruptive source parameters from analogs, such as the 2005 SAV and 1979 La Soufrière (St. Vincent) eruptions. By overlapping probabilistic hazard maps and exposed areas within a GIS, we find that about 700 km^2 could be potentially impacted by 0.01 kg m^2 of tephra accumulation around SAV.

ID: 289

Long range infrasound analysis of explosive activity of Yasur volcano (Vanuatu).

Rebecca Sveva Morelli[1-2], Duccio Gheri[3], Paola Campus[4], Diego Coppola[5], Emanuele Marchetti[3]

[1]*Department of Earth, Environmental and Resource Sciences, University of Naples Federico II*

[2]*National Institute of Geophysics and Volcanology (INGV), Naples Section*

[3]*Department of Earth Sciences, University of Florence*

[4]*CTBTO, Wien*

[5]*Department of Earth Sciences, University of Turin*

Explosive volcanic eruptions are efficient sources of elastic energy in the atmosphere, propagating as low frequency (f<20 Hz) acoustic waves (infrasound) for long distances within atmospheric waveguides. The utility of infrasound has been demonstrated for major explosive eruptions (Volcanic Explosivity Index, VEI>3): its efficiency to track lower energy activity as a function of distance is still under debate.

We present infrasound monitoring of volcanic activity at regional distances using infrasound signals radiated between 2008 and 2018 from the persistent Strombolian activity of Yasur volcano (Vanuatu) and recorded in New Caledonia, at 400 km distance, by the IS22 infrasound array, part of the Comprehensive Nuclear-Test-BanTreaty (CTBT) International Monitoring System (IMS).

To retrieve the pressure at the source, infrasound detections, modulated according to seasonal variations of stratospheric winds, are corrected for attenuation based on real atmospheric specification between the source and the receiver. Subsequently, they are used to evaluate long term (yearly) and short term (hourly) variations of the volcanic activity. Results are compared with thermal anomalies from the MODerate resolution Imaging Spectroradiometer (MODIS) installed on NASA's Terra and Aqua satellites and computed by the MIROVA hotspot detection system.

We show that even at regional (400 km) distances it is possible to track the fluctuations of ordinary explosive activity during periods of optimal propagation of infrasonic waves through the atmosphere.

The resolution retrieved from the analysis allows following variations of activity at hourly time scale, representing an especially valuable source of information in areas where local geophysical observations are missing.

ID: 301

Advancement on ash leachates study at Stromboli volcano from 2019 to 2023

Emanuela Bagnato[1], Daniele Andronico[2], Daniele Cinti[3], Elisabetta Del Bello[3], Tullio Ricci[3], Piergiorgio Scarlato[3], Jacopo Taddeucci[3]

[1]*Istituto Nazionale di Geofisica e Vulcanologia, Osservatorio Vesuviano, Napoli*

[2]*Istituto Nazionale di Geofisica e Vulcanologia, Catania*

[3]*Istituto Nazionale di Geofisica e Vulcanologia, Roma*

Ash often serves as catalysts for the formation of water-soluble salts on their surfaces, thus scavenging volatile elements like sulphur and halogens from the plume. Seventy ash samples selected among those collected at Stromboli from 2019 to 2023 were leached and analysed for major elements. Samples relate to different types of activity, from Strombolian and major explosions to paroxysms, lava flows, landslides and pyroclastic flows due to lava fronts collapses. SEM observations on ash samples revealed the association of NaCl-KCl cubes and anhydrite/gypsum incrustations, as confirmed by the Na-Cl and Ca-SO_4 positive correlations in the leached solutions. Ash leachates S:Cl:F proportions are highly variable in time, reflecting changes in the eruptive style of the volcano as well as plume variation around its time-averaged composition (2019-2023). Nevertheless, S/Cl and S/F molar ratios in ash leachates agree with the Stromboli's plume chemistry, while Cl/F ratios fall within the typical volcanic arc gas range. This suggests a prevalent volcanogenic origin of S, Cl and F, confirming that the adsorption of plume acidic gases onto volcanic ash is among the key controlling factors on ash leachates composition. In detail, S/F and S/Cl molar ratios in ash-leachates increased significantly during the most vigorous episodes, including the July 2019 paroxysm, concurring with a greater volume of volatiles within the plume and the finest nature of the emitted ash. Further increases in ash leachates' molar ratios were observed during explosive and lava flow events occurred during 2021-2023. As expected, the ratios decreased back once the events ended.

ID: 327

High frequency petrological monitoring at open-conduit volcanoes: The case of May 11 2019 explosions at Stromboli volcano (Italy).

Alessio Pontesilli[1], Elisabetta Del Bello[1], Piergiorgio Scarlato[1], Silvio Mollo[1,2], Ben Ellis[3], Daniele Andronico[4], Jacopo Taddeucci[1], Manuela Nazzari[1]

[1] Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Roma 1, Via di Vigna Murata 605, 00143 Roma (RM), Italy;

[2]Dipartimento di Scienze della Terra, Sapienza Università di Roma, P.le Aldo Moro 5, 00185 Roma (RM), Italy;

[3]Institute of Geochemistry and Petrology, ETH Zurich, 8092 Zurich, Switzerland;

[4]Istituto Nazionale di Geofisica e Vulcanologia-Osservatorio Etneo, Sezione di Catania, Catania, Italy;

In this contribution we present a high spatial and high temporal resolution petrological and volcanological investigation using as test site Stromboli volcano. On May 11 2019, we had the rare opportunity to collect individual fresh fallout ash products from eighteen consecutive explosions and to acquire continuous high frequency (50 Hz) infrared thermal data. We observe that explosions were more frequent and ash-dominated at the southwestern crater area (SCA, 8–10 events/hour) than at the northeastern crater area (NCA, 3–5 events/hour), where coarser material was ejected. The statistical analysis of glass and plagioclase compositions reveals differences in the products erupted from the two crater areas. SCA explosions tapped less differentiated magmas, whereas NCA area explosions are more differentiated. Thermometric calculations based on clinopyroxene-plagioclase-melt equilibria highlight that NCA eruptions were fed by a colder magma relative to that feeding SCA eruptions. Diffusion modeling of Li concentration profiles in plagioclase also indicates longer timescales of magma degassing and ascent for NCA eruptions, leading to preferential groundmass crystallization at the conduit walls and transition from sideromelane to tachylite textures. The final emerging picture is that concurrent eruptions from distinct vent areas at Stromboli are heralds of distinct magma differentiation conditions within the uppermost part of the storage region, in agreement with eruptive phenomena. This high-resolution approach has the potential to unequivocally constrain the processes driving transient, rapid, explosive eruptions in active volcanoes, thus offering new insights on the complex interplay between magma dynamics, magma ascent rate, and eruptive behavior.

ID: 376

Dynamics of magma ascent during the 1993 sub-Plinian eruption of Lascar volcano, northern Chile, and implications for hazard assessment

Álvaro Aravena[1,2], Alfredo Esquivel-Cáceres[2,3], Yuvineza Gómez-Leyton[2,3], Pablo Salazar[2,3]

[1]*Universidad Católica del Maule, Talca, Chile.*

[2]*Instituto Milenio de Investigación en Riesgo Volcánico - Ckelar Volcanes, Antofagasta, Chile.*

[3]*Universidad Católica del Norte, Antofagasta, Chile.*

Numerical modeling of volcanic conduits has demonstrated to be a powerful tool to analyze the physical conditions that magmas experience during ascent in the conduit, and has been widely applied for understanding the factors that modulate the eruption style of volcanic events, the interaction dynamics between the ascending magma and the country rocks, and the main processes controlling the physical properties of the ascending magma during specific volcanic eruptions. In this investigation, we adopt the program MAMMA to reproduce the magma ascent dynamics during the 1993 sub-Plinian eruption of Lascar volcano, northern Chile. Based on petrological, geochemical and volcanological data of the eruption and the development of a sensitivity analysis, we constrained key information of the studied event (e.g., exit velocity, exit pressure, and fragmentation depth) and we determined the magma reservoir conditions that mostly control the characteristics of an eruption generated by the rise of a magma similar to that observed in recent eruptions of Lascar volcano. Understanding the ascent dynamics of magma in a recent eruption of a given volcanic system, such as exsolution and fragmentation depth, may allow us to interpret better geophysical information derived from volcano monitoring and define the key magma characteristics that will control the hazard associated with future eruptions.

ID: 434

Phreatomagmatic fragmentation and tephra deposition at Blue Lake Crater, Oregon, USA

Sophia Leiter[1], Pierre-Simon Ross[1], Emily Johnson[2]

[1]*Institut national de la recherche scientifique, Quebec, QC, Canada*

[2]*U.S. Geological Survey, Cascades Volcano Observatory, Vancouver, Washington 98683, USA*

Blue Lake is a basaltic andesite maar volcano located in the Central Oregon Cascades, USA. It erupted <3 ka making it one of the youngest eruptions in the Cascades (Johnson & Cashman, 2020). The eruption excavated a ~500 by 1000 m crater and produced interlayered lithic-rich phreatomagmatic fallout deposits and surges, as well as magmatic fallout. The tephra sheet extends up to 11 km from the crater in the NNE direction. Here we present detailed stratigraphy for each of the eruptive units including grain size distribution, componentry, and for the juvenile ash, morphometric parameters, crystallinity, and vesicularity collected from 20 tephra pits, based on the standardized method outlined in Comida et al. (2022) and Ross et al. (2022). Additionally, we expanded the existing isopach map, and drew a total thickness isopleth map, as well as isopach and isopleth maps for individual units. Stratigraphy shows the evolution from the initial lithic-rich phreatomagmatic excavation phase to phreatomagmatic base surges intercalated with and overlain by lithic-rich fall deposits. The final package of juvenile-rich fall deposits represents a shift to purely or dominantly magmatic behavior that ends the eruption. The componentry and grain size vary over the course of each package of units, representing changes in explosivity and column height. We are compiling a dataset of morphometric parameters, crystallinity, and vesicularity for 30 samples, that will illuminate differences in fragmentation between units, expanding our understanding of the eruption dynamics over the course of the eruption.

ID: 521

Sboffing and ringing: active degassing styles at Etna in 2023

C. Biensan[1] J. Taddeucci[1], T. Ricci[1];E. Del Bello[1], P. Scarlato[1]

[1]*Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy.*

Active magma degassing is the release of slightly over-pressurized gas pockets from volcanic vents. This activity can shed light on the geometry of the shallow plumbing system of volcanoes and its internal dynamics. During a field campaign in summer 2023, we collected ten consecutive days of thermal infrared recording of active degassing at the Bocca Nuova area of Mt. Etna. Two vents displayed active degassing. The first, hereafter referred to as 'sboffer', was a crater that produced loud, low-frequency sound (hence the name) that accompanied each degassing event. The second, hereafter referred to as 'ringer', was a circular pit on the ground from which volcanic vortex rings, similar to smoke rings (hence the name) were often emitted during the events. We characterized the emissions from both vents by analyzing the brightness temperature anomalies generated by each event on several horizontal measurement lines traced above the vents in the thermal video recordings. Both vents produced events with a bimodal distribution in intensity and duration. In particular, Sboffer produced large events with a mean amplitude of 100-160°C and recurrence time of about 500 s, and smaller ones of amplitude 20-24 °C every 200-400 s ca. Larger and smaller events at Ringer had amplitudes 70-100 and 20-23 °C and occurred with a much higher frequency of every 4 and 1.5 s, respectively. Exit velocity for large events were of 15 and 10 m/s for sboffer and ringer, respectively. All parameters at both vents remained overall remarkably stable during the ten days.

ID: 630

Vent determination in explosive eruptions using multidisciplinary approach: application at Joya Honda Maar, Mexico.

Rodríguez Sedano Luis Ángel[1], Cerca Ruiz, Maria Fernanda[2], Sarocchi Damiano[2], Almaguer Rodríguez Joselin[2], Solano Monge, Juan Pablo[2], Saucedo, Ricardo[2], Randall Guevara Betancourt[3], Boris Chako-Tchamabé[4]

[1]CONAHCYT-Instituto de Geología, Universidad Autónoma de San Luis Potosí, Av. Dr. M. Nava No 5, Zona Universitaria, 78240, San Luis Potosí, México; [2]Instituto de Geología/Facultad de Ingeniería-UASLP, 78240, San Luis Potosí, México; [3]CONAHCYT-Instituto Potosino de Investigación Científica y Tecnológica A.C., San Luis Potosí, México; [4]Instituto de Investigacionesen Ciencias de la Tierra, Universidad Michoacana de San Nicolás de Hidalgo, Morelia, Michoacán, Mexico.

Joya Honda (JH) volcano is a Maar-diatreme type volcano, located in San Luis Potosí, Mexico. It belongs to the San Luis Potosí Volcanic Field (CVSLP), which also includes other monogenic volcanoes such as Pozo del Carmen and Crater Encantado. JH has been studied from different point of view and according to the literature its eruption dates back to approximately 311±19 ka. It is thought that the eruption of JH came from two different emission centers located to the N and S of the crater. In the present work we show new evidence that points out there were three possible or more emission centers located along a fault oriented N-S. All this mainly based on a Quantitative Textural Analysis (QTA) focused on the shape-fabric analysis. The shape-fabric refers to the analysis of orientation and degree of 3D isorientation of elongated clasts and crystals. With this information it is possible to argue possible directions of provenance of volcano-sedimentary deposits related to currents or granular flows quantitatively. A total of more than 70 samples oriented around the JH crater were collected. The results of a geophysical study (magnetometry) conducted in the JH crater and its surroundings are also reported, as well as the results of a ballistic impact analysis. All these results support the information collected by the ATQ. This demonstrates the versatility and accuracy of this easy to use and low-cost methodology and its applicability in other Maars or any volcanic structure in the world.

ID: 641

High-resolution geochemical characterization of Irazú's magmatic evolution over the last 2000 years

Forrest E. Dabbs[1], Paulo Hidalgo-Odio[2], Guillermo E. Alvarado[3], Daniela Campos-Durán[4], Peter C. Ryan[5]

[1]Geosciences, Georgia State University, Atlanta, United States; [2]Centro Investigaciones Ciencias Geológicas, Universidad de Costa Rica, San José, Costa Rica; [3]Escuela de Geografía, Universidad Nacional, Heredia, Costa Rica, [4]Earth and Climate Sciences, Middlebury College, Middlebury, United States

Irazú Volcano is an active andesitic shield volcano located ~15 kilometers northeast of Costa Rica's second-largest city, Cartago. Tephra deposits from the past 2600 years confirm that Irazú's history is punctuated with phreatomagmatic, magmatic, and phreatic eruptions that produced ashfall, small pyroclastic flows, and lahars. However, geological studies have concentrated on the latest eruptions (1963-1965) and lack a geochemical assessment of Irazú's ~2000 years of activity. Inductively coupled plasma mass spectrometry (ICP-MS) and x-ray fluorescence (XRF), major and trace elements of ash and whole-rock tephra deposits were measured to model Irazú's magmatic evolution and ascertain eruptive trends. This geochemical characterization is correlated with Irazú's stratigraphic columns to illustrate Irazú's volatile trends. This work defines a geochemical approach to hazard mapping that could benefit 60% of the nation's population. The high-resolution magmatic trends measured in this project are directly linked to the magma's viscosity and the mineral cargo and were used to model volatile abundance. The reach of this study is exemplified by our international and local partnerships with the National Risk Prevention Commission and Emergency Care (CNE) of Costa Rica, the Costa Rican National Park Service, the local ASADA (Community Water Management Association), and the University of Barcelona School of Geographic Sciences. The composition of tephra is a pivotal factor in understanding the wide-ranging hazards associated with volcanic eruptions. Our results could contribute to building effective disaster preparedness and response systems and generate local educational programs regarding Irazú's volcanic activity.

ID: 657

Numerical reconstruction of the Late Pleistocene X-6 eruption from Campi Flegrei (~109 ka)

Giada Fernandez[1], Antonio Costa[2], Biagio Giaccio[3], Danilo M. Palladino[1], Gianluca Sottili[1]

[1]Department of Earth Sciences, "Sapienza" University of Rome, Rome, Italy; [2]Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Bologna, Bologna, Italy; [3]Istituto di Geologia Ambientale e Geoingegneria, CNR, Rome, Italy

A detailed reconstruction of the physical parameters (e.g., style and magnitude) and tempo of the past explosive volcanism are pivotal for hazard assessment and risk mitigation. With this regard, the study of tephra layers recorded in proximal and distal successions has been recognized as a powerful tool for reconstructing the eruptive history of volcanoes.

Campi Flegrei (CF) caldera, located west of the urban area of Naples (southern Italy), is among the most productive volcanoes of the Mediterranean area. Its volcanic history comprises so far two well-known caldera-forming eruptions (e.g., Campanian Ignimbrite, CI, ~40 ka; Neapolitan Yellow Tuff, NYT, ~14 ka).

Recently, tephra fallout deposits from mid-proximal, distal and ultra-distal settings, analysed from a stratigraphic, compositional and chronological point of view, were all correlated to some poorly known and important Late Pleistocene marker tephra in the Mediterranean area (e.g., X-6/Maddaloni, X-5/Montemaoro, C-22).

These eruptions are still poorly constrained and need further investigations. However, for the X-6/Maddaloni eruption (~109 ka) we have enough pieces of information derived from field data and laboratory analysis. Thus, this dataset, combined with the tephra dispersal model HAZMAP, allowed us to reconstruct, for the first time, some of the Eruption Source Parameters (ESP; e.g., column height, tephra fall volume, erupted mass) and dispersal areas.

The adopted method will be crucial for a more detailed magnitude assessment of the CF past explosive eruptions, useful for improving the volcanic hazard assessment in the Neapolitan area.

ID: 698

Reconstrucción de la erupción de abril de 1993 del volcán Lascar mediante modelos numéricos

Alfredo Esquivel[1,2], Felipe Aguilera[1,2]

[1]Instituto Milenio de Investigación en Riesgo Volcánico - Ckelar Volcanes, Antofagasta, Chile; [2]Departamento de Ciencias Geológicas, Universidad Católica del Norte, Antofagasta, Chile

Las erupciones volcánicas y sus consecuencias se asocian a múltiples peligros, que plantean amenazas a corto y largo plazo para las personas y la propiedad. Por lo que resulta fundamental comprender y cuantificar la intensidad, alcance y probabilidad de que ocurran estos peligros. El volcán Lascar es el más activo y peligroso del norte de Chile, su erupción más intensa en tiempos históricos ocurrió el 19 y 20 de abril de 1993, se generaron flujos piroclásticos con alcances de hasta 8 km, y dispersión y caída de tefra que se movilizó por cientos de kilómetros. El objetivo de esta investigación es precisar los parámetros fuente físicos de procesos volcánicos mediante la reconstrucción de la erupción descrita del volcán Lascar. Se desarrolló i) trabajo de campo con mediciones y muestreo de los depósitos volcánicos; ii) análisis granulométrico y cálculo de parámetros físicos eruptivos y iii) modelamiento numérico que valida la reconstrucción propuesta. La reconstrucción se caracterizó por presentar flujos piroclásticos con un volumen total de 0,0913 km^3 y velocidades de hasta 40,89 m/s. La dispersión y caída de tefra se originó a partir de una columna eruptiva de 22,6 km, un volumen de 0,052566 km^3 y un total de $6,12x10^{10}$ de masa erupcionada. La granulometría se caracterizó por clastos de tamaño máximo de 1,8 cm, una distribución total de tamaño de grano de media -4φ. Esta erupción se puede clasificar con una intensidad 8,85, VEI 4, y magnitud 3,78 a partir de un volumen total erupcionado de 0,143766 km^3.

ID: 729

Las cenizas de erupciones de julio de 2013 versus erupciones de mayo de 2023, del volcán Popocatépetl, centro de México

Felipe García Tenorio[1] , Irma Fabiola Mendiola López[2]

[1]*Laboratorio de Petrografía, Instituto de Geofísica, Unidad Michoacán, Universidad Nacional Autónoma de México,*

[2]*Laboratorio de Análisis de Partículas y Separación de Minerales, Instituto de Geofísica, Unidad Michoacán, Universidad Nacional Autónoma de México*

El volcán Popocatépetl situado a 70 km al sureste de la ciudad de México, desde el 2006 hasta el día de hoy, ha estado caracterizada por la construcción y destrucción eruptiva de domos de lava. El presente estudio analiza erupciones del 2013 y 2023. Las muestras analizadas se colectaron entre 15, 19 y 27.5 Km al NW del cráter.

Erupciones de 2013: Comprenden muestras de erupciones ocurridas los días 3, 4 y 5 de julio, y consisten de depósitos de caída compuestas de 15-22% de líticos, 17-22% de ferromagnesianos (piroxeno, olivino, anfíbol y biotita) y 25-33% de plagioclasa, y tienen componentes: juveniles de 85-93 %, accesorios de 7-9 % y accidentales de 1 %. Agregados de ceniza se observaron en las cenizas de los días 3 y 4.

Erupciones de 2013: Se analizaron las ocurridas el día 20 de mayo, consisten de depósitos de caída compuestas de 8.5 % de líticos, 3.3 % de piroxenos, 88 % de plagioclasa, 0.1 % de pómez y 0.1 % de escorias, y comprenden 99 % de componentes juveniles y 0.21 % de componentes accesorios. Las diferencias granulométricas y en componentes de ambas erupciones sugieren que tuvieron implicaciones de fragmentación diferentes y que la composición mineralógica del magma ha tenido variaciones. En ambas erupciones, la población de la vertiente NW y W-NW del Popocatépetl estuvo expuesta a >24 horas por la caída de estas cenizas, es por ello la importancia de analizar las cenizas de caída por los daños que causan a la población

ID: 751

Evidencias de Erupciones de Gran Magnitud en Isla Clarión, México: Implicaciones para el Riesgo

Marco Julio Rodríguez Delgado[1], Aldo Patricio Ruiz Galindo[1], Nicholas Robert Varley[1], Julie Roberge[2]

[1]Facultad de Ciencias, Universidad de Colima, Colima, México; [2]Escuela Superior de Ingeniería y Arquitectura, Unidad Ticomán, Instituto Politécnico Nacional, Ciudad de México, México

Isla Clarión se encuentra en el Pacífico Oriental Tropical mexicano, aproximadamente a 700 km de Baja California Sur. Es una de las cuatro islas volcánicas que conforman al Archipiélago de Revillagigedo, el cual no tiene un vulcanismo bien definido sobre el marco tectónico regional en el que se eleva.

Isla Clarión ha presentado estilos de actividad efusiva y explosiva a lo largo de su historia, donde aún remanan diferentes depósitos piroclásticos asociados a erupciones de gran magnitud distribuidos en amplias regiones de la isla. La morfología del norte está conformada por acantilados que presentan diques y fallas que podrían demostrar colapsos asociados a la formación de una caldera.

No existen evidencias de actividad volcánica reciente, sin embargo, los riesgos implicados más probables serían aquellos asociados a la remoción de masa debido a la susceptibilidad de colapso de los acantilados del norte, no obstante, una erupción de gran magnitud futura ligada a largos periodos de reposo no se puede descartar hasta el momento, y para ello, es necesario realizar más investigación que determine el estado de actividad de la isla, sin embargo, las factores como el intemperismo y la morfología de la isla observados en este proyecto han reducido la incertidumbre.

Los depósitos de ignimbritas evidencian las múltiples actividades destructivas que Isla Clarión ha presentado, por lo cual, caracterizar depósitos relacionados a actividad Pliniana puede generar una idea del mecanismo y las implicaciones de erupciones someras submarinas de gran magnitud, como lo sucedido por la erupción en Tonga en 2022.

ID: 776

Effect of fluidization in increasing run-out distance of granular flows for different aspect ratio collapsing columns

Alvaro Aravena[1,2,3], Thierry Dubois[4], Laurent Chupin[4], Olivier Roche[2]

[1]*Facultad de Ciencias Básicas, Universidad Católica del Maule, Talca, Chile.*

[2]*Laboratoire Magmas et Volcans, Université Clermont Auvergne, CNRS, IRD, OPGC, Clermont-Ferrand, France.*

[3]*Millennium Institute on Volcanic Risk Research – Ckelar Volcanoes, Antofagasta, Chile.*

[4]*Laboratoire de Mathématiques Blaise Pascal, Université Clermont Auvergne, CNRS, Clermont-Ferrand, France.*

We investigate the propagation dynamics of fluidized granular flows on horizontal channels in order to evaluate the factors controlling the efficiency of fluidization in increasing the run-out distance. We adopted a two-phase numerical model able to reproduce dam-break experiments, which allows describing depth-dependent variations of flow properties and the effect of pore pressure in the granular material rheology. We show that the interplay between column collapse timescale and flow front velocity plays a primary role in determining the effective influence of fluidization on run-out distance. For high aspect ratio columns, a significant portion of the collapse occurs when the flow front has traveled a long distance from the reservoir and, importantly, the decrease of basal pore pressure with time in the reservoir translates into a reduced velocity of the granular material entering into the propagation channel during final phases of column collapse. Thus, at some point, the collapsing material is not able to affect significantly the flow front dynamics. Comparison with experimental data also reveals that the effective pore pressure diffusion coefficient is an increasing function of column height, and can be considered as proportional to a weighted average of flow thickness. Our observations suggest that the effect of fluidization in increasing run-out distance is limited under conditions of impulsive collapse of large-scale fluidized columns with no initial velocity. This has important implications in the long-lasting debate on the influence of fluidization in the transport dynamics of PDCs and thus for hazard assessment.